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The First Swallow

POLYMORPH is among the newest names to echo round the aeronautical world. It connotes an aircraft that is capable of assuming various shapes; and although the word itself is a new accession to the vocabulary of the air, the idea it conveys is probably older than powered flight itself. This same idea remains one of the greatest challenges in aeronautical engineering, though it has now been brought near to realization with the placing of a design-study contract for a deck-landing version of the variable-sweep, variable-incidence, variable-jet, Wallis Swallow. Such an aircraft, capable of flying a standing patrol in slow-speed configuration and of supersonic attack with wings swept back, may be a far cry from the Mach 2.5 Australia-non-stop airliner envisaged by Dr Barnes Wallis. But it seems a sensible first step along the road to full-scale development and could yet prove to be the most historic aeroplane since the Wrights'.

Commonwealth Airline Partnerships

IN the next few weeks BOAC will be operating in pool with the Commonwealth carriers Trans-Canada Air Lines and Air-India. Both pools, though quite distinct, will provide for the sharing of revenues on a pre-determined basis, the joint selling of tickets, and the rationalization of schedules.

Thus BOAC are soon to go commercially arm in arm with four big Commonwealth airlines on a substantial portion of the corporation's route system. From April 1 Air-India comes into the partnership operated successfully (if not without conflict) with Qantas for a quarter of a century; the existing pool agreement with South African Airways continues; and from March 1 the UK-Canada routes will be shared with TCA.

Many important commercial advantages will accrue to the carriers concerned, among them a reduction of wasted capacity. Of course, pool agreements are in no way as binding as the sort of treaty that, in Air Union, will weld together Air France, Lufthansa, Alitalia and Sabena. The pools which BOAC have contracted to enter do not differ in any basic principle from those which BEA operate with their fourteen European competitors.

So to what extent has the Commonwealth spirit sponsored BOAC's new partnerships? This would be as hard to define as the Commonwealth spirit itself. But it is reasonable to suggest that the Commonwealth idea provided a sort of rallying point for airlines who felt that, in an air transport world dominated by the Americans, unity is strength. It is in this respect that the Commonwealth partnership resembles Air Union—though it involves nothing like the same measure of commercial, technical, financial and operational integration which, probably on April 1, 1961, will make Air Union as unified an airline as SAS.

No doubt the Americans have been attentively watching these Commonwealth and Air Union rank-closing trends. They have one ace up their sleeve should these or any other airline blocs seriously challenge the influence and bargaining powers of America's international airlines. The Americans are very hostile towards cartels, and it is conceivable that US anti-trust laws could be invoked to question the monopolistic nature of airline groups should ever disputes arise about traffic rights. The onus will be upon the blocs to prove that their partnerships are in the public interest.

FROM ALL QUARTERS

Sir Dermot's Farewell

IN a farewell message on his retirement as Chief of the Air Staff on December 31, Marshal of the RAF Sir Dermot Boyle said that the four years of his tour had been "rich beyond measure with unforgettable experiences." Addressing his thanks to all members of the RAF for their support, the retiring CAS added: "The Royal Air Force stands in the front line of Britain's defences and bears an unprecedented and tremendous responsibility for the country's future and well-being. I am confident that this responsibility is well placed in your hands and it is this thought which has constantly sustained me and immeasurably lightened my own responsibilities." [See also page 52.]

BEA to Buy American?

THE most significant aspect of BEA's application last week to operate helicopter services from London to Paris, Brussels and Amsterdam (and on the domestic routes to Birmingham and/or Manchester) is the proposed use of Sikorsky S-61s or Vertol 107s. No mention is made of the Bristol 192C, which is now presumably out of the running in BEA's plans for a helicopter to precede, and later to supplement, Rotodynes. Whether the S-61 or the Vertol is chosen, the order will be BEA's first ever placed with the American aircraft industry.

The BEA helicopter services to the Continental points applied for and to Birmingham and/or Manchester will probably start in 1962. The corporation will first operate a service between Land's End and the Scilly Islands some time in 1961.

NA.39 Ejection Tests in USA

HIGH-SPEED ejection through the Blackburn NA.39 canopy is to be tried out in the near future on the US Navy's rocket sled testing facilities at China Lake, Cal. Tests will be made on the SNORT (supersonic naval ordnance research track, a stretch of four miles) and an actual NA.39 front fuselage employed—see illustration on facing page—with a steel bay built behind it to contain the propulsion rockets. On the side of the fuselage the aircraft is described as a "low altitude bomber/reconnaisance aircraft, designed and manufactured by Blackburn Aircraft Ltd, Brough, Yorkshire, England."

In an article on aircrew escape from the NA.39, in the current issue of the Blackburn house journal *The Courier*, A. E. Rowland, Head of the Structures Department, writes of the special difficulties of ejection from an aircraft designed to fly "low and fast" and describes the static tests of the NA.39 ejector system which have already taken place at Brough. So far, he says, these have shown the system to be "as perfect as static tests could make it." In the high-speed tests—the first to be made by sled of a British military aircraft—the two seats will be fired from the cockpit six times. The seats are, of course, Martin-Baker automatics.

In a New Year message the chairman of the Blackburn Group, A. F. Jopling, says he considers the concern has never been "in better shape in relation to the aircraft industry as a whole." He pays tribute to Eric Turner, who resigned as chairman and managing director on December 31, and to the team which he built up and led "with conspicuous success." Mr. Jopling refers to the production order for the NA.39 and says "we have recently been told that the A129 engine is to be ordered for installation in the Saunders-Roe P.531 [Wasp]."

Hawker Siddeley Results

SO rapid was the growth of Hawker Siddeley in Canada in recent years that the tail was threatening to wag the dog: the stage was about to be reached where the value of the Canadian subsidiaries exceeded that of the UK parent companies. Now the accounts for the year ended July 1959—issued recently in advance of the a.g.m. on January 14—show that this trend has been sharply reversed.

In broad terms, the book value of the British and Canadian concerns in 1958, after allowing for shares held in subsidiary companies by outsiders, stood at about £50m in each case. But by the close of the 1959 financial year the British part of the business rocketed in book value to almost £70m, whereas the Canadian section remained more or less unchanged.

A similar picture appeared on the profits side. That Britain is no longer a poor relation is shown by a net profit figure for 1959 of £5m. The Canadian figure was only half this amount, and over half of that went to outside shareholders.

The main feature of the Hawker Siddeley balance sheet is the progress the group is making away from indebtedness. Raising of a £15m debenture loan in the UK allowed bank loans and overdrafts to be substantially reduced, while sale of their £7½m share in Algoma Steel allowed the Canadian group to pay off most of their overdrafts also.

It is interesting to compare the book value of this enterprise with that shown on the Stock Exchange. At the time of the announced take-over of de Havilland, the market value of Hawker Siddeley shares stood at £44m. The 1959 accounts, after allowing for debenture shares and double-counting between parent company and subsidiaries, show a figure of £64m.

WASP'S NEST for the Saunders-Roe P.531, which now bears this insect's name, was provided by HMS "Undaunted" during recent evaluation trials (referred to on this page last week). Here the helicopter is making one of its 300-odd deck landings on the frigate

Thirteenth Recognition Contest

THIS year's All-England annual aircraft recognition competition, organized by the Aircraft Recognition Society, is to take place at the Royal Commonwealth Society (Craven Street entrance), London, WC2, on Saturday, January 23. The thirteenth to be held, it is open to teams of three members representing units of the Services (including the ROC, ATC and WJAC) or any recognized club, society or body interested in aircraft. Air Cdre G. J. C. Paul, Secretary-General of the Air League, is to umpire the competition, and six trophies are to be contested.

Firth Cleveland Acquire Solartron

FOLLOWING an approach made by the Solartron Electronic Group Ltd for assistance to finance development during the next five years, the Firth Cleveland Holding & Investment Co Ltd is to acquire a controlling interest in Solartron. The latter organization, who design and manufacture electronic and electro-magnetic equipment, came into being less than ten years ago and have since then put on the market some 140 proprietary products. In the aeronautical field, these include radar simulators, telemetry equipment and test instruments. The agreement with Firth Cleveland will provide £900,000 immediately for development and expansion.

Solartron's sales have increased from £30,000 in 1950 to over £2m in the year ended last April, and during this period almost

LICENCE CONSTRUCTION in India of the Rolls-Royce Dart was the subject of an agreement signed last week by Mrs V. L. Pandit, Indian High Commissioner in London, and Air Marshal Sir Colin Weedon

the whole of the profits have been used for research and development. Recently the time came to look elsewhere for financial support, and accordingly the chairman and managing director, J. E. Bolton, approached C. W. Hayward, chairman of Firth Cleveland, whom he has known for many years. Mr Hayward is to become chairman of Solartron and Gordon Harries, secretary of Firth Cleveland, will join the board. Mr Bolton becomes deputy chairman and managing director. The Firth Cleveland Group, which itself came into existence only in 1953, now owns nearly 60 companies. Among these are Firth Cleveland Instruments Ltd and Simmonds Aerocessories.

More Martin-Baker Seats

MOST recent of the Martin-Baker ejection seat conversions for the German Air Force was inspected by German officials at Chalgrove Airfield last month. The fully automatic Mk GU5 was shown installed in a Lockheed T-33 trainer. Although this seat retains all the automatic features, including the personal-equipment connector, the parachute has been relocated in the seat pan and the dinghy pack omitted. In this way the occupant sits further back and the ejection angle can be made greater than the 14° of the original American installation. The two Mk 5 seats in the T-33 are interchangeable.

Last August a German team inspected the installation of the Martin-Baker Mk GW5 seat now fitted in German Sabre 6s and the installation of the Mk GQ5 seat in German F-104s was discussed during the more recent visit.

Continental Round-up

A PERIOD of fairly intense political bargaining within NATO has turned certain French aircraft and missile projects into political bargaining counters—a situation which often leads to unexpected results. For her domestic reasons France has been holding back from the proposed NATO integrated air defence system, and the adoption by foreign air forces of the Mirage III fighter/bomber may be an important consideration in this attitude. The US, for its part, has apparently refused technical assistance for a French IRBM—also a reasonable bargaining point.

Although the Swiss Government is reported to be considering the Mirage III, the recent Dutch adoption of the Lockheed F-104G seems to have confirmed the latter as an almost universal choice. The Mirage III should enter service with the French Air Force at the end of this year but the type will probably not be available for export until late 1961. The cost of a fully equipped Mirage III is stated to be "well under a million dollars." To the RAAF Dassault have offered a special Anglicized version powered by a Rolls-Royce RB.146.

French first-generation nuclear delivery has now been entrusted to the smaller version of the Mirage IV and the larger version, powered by SNECMA-built P & W J75s, has been abandoned in favour of the lighter "strike and escape to neutral territory" concept (the J75 licence has been abandoned). It is intended that delivery of the first 50 Mirage IVs will be made by the end of 1965, with three pre-production and seven production aircraft in 1963 and 22 more in 1964.

Where international co-operation is less directly involved in politics the French aircraft industry is faring a great deal better, considerable resources being devoted to the Franco-German Transall and the Bréguet 1150 ocean patroller (both powered by two Tynes) and the Sud-Fiat crane project. French electronics companies are associated with Marconi and Decca radar, and both Rolls-Royce and Bristol Siddeley are providing engines for various NATO joint-venture aircraft. Beyond this, Britain seems to be as unwilling to join in NATO aircraft projects as France is to commit herself unreservedly to certain NATO requirements. British contributions to the German and Dutch F-104s will include Martin-Baker ejection seats, and Ferranti Airpass fire control might possibly be supplied for the Dutch machines.

Airpass, probably in a combined ground-attack and interception form (a version of Airpass is already installed in an NA.39), stands a very good chance in any exported Mirage III, particularly those which might go to Switzerland and Australia. The same applies to the Saab Draken which is now being inspected by the Swiss. Sweden's own Drakens might also be equipped with Airpass, and this fire control could also be accommodated even in the lightest fighters.

IN BRIEF

The contract recently awarded by the Canadian Department of Defence to de Havilland Aircraft of Canada Ltd, for 27 Otters for the RCAF, is worth £1,068,000.

Chance Vought have received a $58m follow-on contract for F8U-2N Crusaders from the US Navy. Previous F8U-2 contracts were valued at $25.6m and $10m. The -2N is equipped with Martin-Baker "ground-level" ejection seats.

Dr George Macfarlane, a deputy chief scientific officer at the RRE Malvern, has been appointed Deputy Director of the National Physical Laboratory. He succeeds Dr Edward Lee, who becomes Director of Stations and Industry Divisions at the headquarters of the D.S.I.R.

Bristol Siddeley Engines give news of the retirement of C. M. Tunstall, assistant works manager, development manufacturing (aero). His association with the organization dates back as far as 1916, when he first joined Siddeley Deasey Ltd., which later became Armstrong Siddeley Motors.

Well remembered as an RFC and RAE pilot and as Hawker chief test pilot from 1933 to 1945, Gp Capt P. W. S. ("George") Bulman, CBE, MC, AFC, FRAeS, has been forced by ill-health to resign from Bryans Aeroquipment Ltd after 14 years as a director. He is succeeded by Kenneth J. Wilson, son of K. H. Wilson, who was until recently the chairman of Albright & Wilson, the manufacturing chemists.

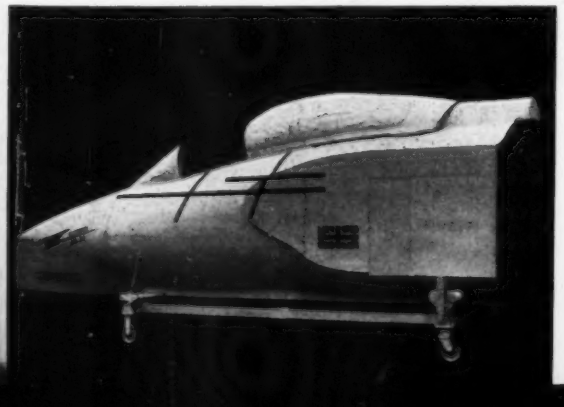
Following a successful sales campaign during 1959, all the first batch of the new Hiller 12E helicopter (US Army designation, H-23D Raven) have been sold and increased production has been planned for this year. A price reduction to $55,950 ex-works also comes into effect immediately. British agents for Hiller are Helicopter Sales Ltd, 2 Lowndes Street, London, SW1. Allied International Corporation, of 230 Park Avenue, New York, have been appointed distributors for the United Arab Republic, Lebanon, Kuwait and Iraq. Powered by a 305 h.p. Lycoming VO-540, the 12E cruises at 82 m.p.h. for almost three hours, carries a useful load of 1,000lb and has a service ceiling of 15,000ft.

The last three squadrons of US fighter-bombers based in France were being transferred to Lakenheath, Suffolk, last Wednesday. Equipped with F-100s, they are the 492nd, 493rd and 494th Squadrons of the 48th Tactical Fighter Wing.

The Yugoslavia Purchasing Commission which recently visited Britain has signed a contract with G.E.C. Overseas Services Ltd. for airport lighting equipment, valued at about £75,000, to be installed at Belgrade and Zagreb airports.

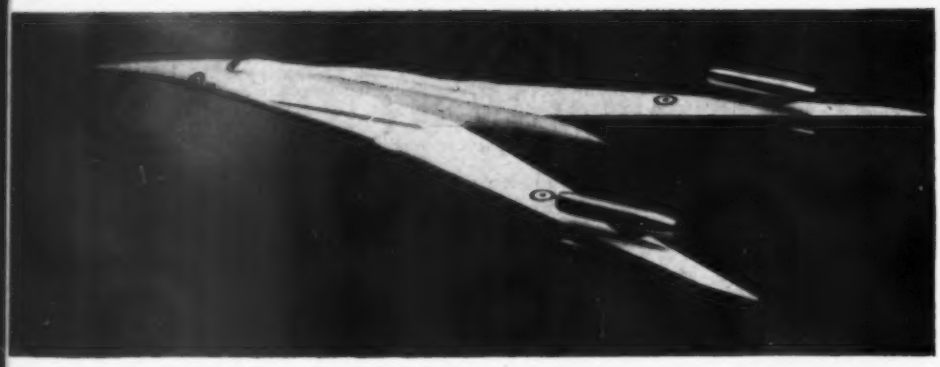
A British-made film based on *Thunder Above*, the novel by A. J. Wallis and Brig-Gen Charles F. Blair, Jr, referred to on this page recently, is to have its London première this spring. Entitled *Beyond the Curtain*, it stars Richard Greene as an airline captain and Eva Bartok as a stewardess. The film is being distributed by the Rank organization.

An attractive offer of free flying training for purchasers of Jodel D.117 aircraft from Rollason Aircraft & Engines Ltd of Croydon (UK agents for Société Aéronautique Normande) was announced on January 1. Cost of the aircraft, including automatic starter for the 90 h.p. Continental and an eleven-channel VHF two-way radio, is £2,600. The flying training, covering the syllabus for the Private Pilot's Licence, will be carried out on the aircraft purchased and will be made available at any flying club, school or centre in the United Kingdom. The company are aiming particularly at making this type of flying attractive to executives of small and medium-size companies with interests in this country and on the Continent.



***SHORT SNORT:** The rocket-propelled sled to be used in high-speed ejection tests for the Blackburn NA.39, described opposite. The site, in California, is the Supersonic Naval Ordnance Research Track (SNORT). There is no sled track in the British Commonwealth*

***ON OFFER** to several countries as a relatively inexpensive Mach 2 fighter/bomber is the Marcel Dassault Mirage III (reheat SNECMA Atar), seen in this recent picture with tandem-slung bombs and under-wing rocket packs. (See "Continental Round-up" on this page)*



Last week we published a photograph of a model of one of the Swallow projects with its wings in the spread position. Here is the same model in supersonic configuration, with the wings swept back at an acute angle. The fuselage is broad and flat

Vickers' Aero Research Chief Reveals the Principles of his Variable-geometry "Swallow"

BARNES WALLIS TALKS

TO hold an audience of teenagers enrapt in attentive silence for an hour and a half and to talk for that length of time unhesitatingly, without notes, is a remarkable feat. When the subject ranges from Ptolemy to hypersonic flight an achievement of this nature is even more outstanding. It is also (in these days, when anything for public consumption is written, or talked, down to an incredibly banal "kiddiewinkie" level) a clear lesson that an intelligent approach is acceptable at any age. But Dr. Barnes Wallis, chief of aeronautical research and development, Vickers Ltd, succeeded brilliantly in this respect when he gave his Christmas lecture to young people, at the Institution of Civil Engineers on December 30.

Dr Wallis had chosen as the subject of his talk "High Speed Communications Link the Commonwealth." Characteristically he first acknowledged those who had helped him, then explained that he proposed to trace the part played by communication in the development of Britain and her seaways and airways that link her trade with the world. The preliminary part of the lecture explaining the geographical advantages of the British Isles, with the help of some unusual map projections, was as interesting as any of it, the whole talk being homogeneous with a fascinating unfolding of the theme toward its supersonic climax.

One of the points made was that sea transport is still the cheapest of all and that it costs less to bring wheat or ore from Canada than to transport the same cargoes around in North America. It costs twenty-five times as much to move coal by land as it does by sea. Dr Wallis also quoted as an example the transport of a ton of wheat 3,000 n.m. from Montreal to Avonmouth for 42s 6d, whereas the charge for the 150-mile land journey on to Plymouth is 27s 6d.

To consolidate the issue of sea transport Dr Wallis showed two slides of his laminar-flow water bodies, which can best be described as very elongated ovoids travelling slim end first. The photos had been taken in one of the NPL water tanks, the laminar flow being revealed by an ink trace released at the bow which drew a steady line along the surface; at 10kt almost to the tail, where it was tripped by a wire, and at 30 kt for rather over half the length of the body. (Laminarization appeared to have been achieved solely by designing to a constant pressure gradient as in the Lightfoot aerofoils.—J.H.S.) By travelling beneath the surface, the vessel is not only relieved of the need to reduce speed in heavy weather, but is freed from surface turbulence, drag being reduced virtually to the skin friction value. The power required to drive a 30ft diameter submarine at 30kt would be "insignificant" compared with that used at eight to 10kt by a surface tramp steamer. Given nuclear propulsion, such vessels would not only be immune from attack, but could greatly reduce the cost of sea transport. "As usual nobody took the slightest notice of the ideas put forward" by Dr Wallis until the polar voyage of USS *Nautilus*. Such vessels would maintain our position as mistress of the seas, since the freight submarine could travel to the Pacific Ocean along 0° longitude across the Pole, and through the 90ft deep, 56 mile wide Bering Strait, which is only 3,780 n.m. distant.

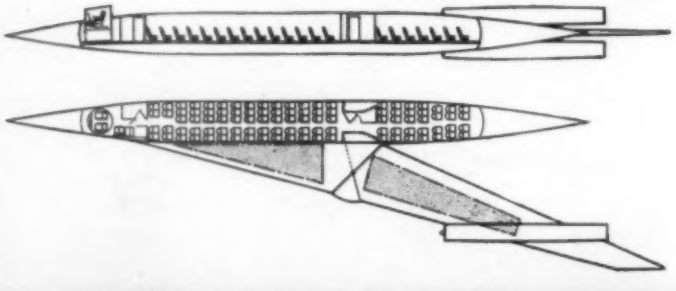
Turning to air transport, Dr Wallis said that there was not much to choose between the efficiency of the various subsonic jet airliner layouts. When it comes to supersonic flight it is plain that the aeronautical world is *exceedingly* puzzled over what to do about the Mach line—the bow shockwave. Showing a slide of several current fighters, Dr Wallis said that they achieve supersonic flight by brute strength, for a few minutes only because of the fantastic fuel consumption. So difficult is the reduction of supersonic drag, while retaining a wing capable of reasonable take-offs and landings, that Dr A. A. Griffith of Rolls-Royce had decided to throw the low-speed wing overboard in favour of direct jet-lift engines. Great as was his respect for his lifelong friend, this was *not* the right solution because of the weight of fuel—particularly that required for landing after deceleration from supersonic flight and stopping in mid-air.

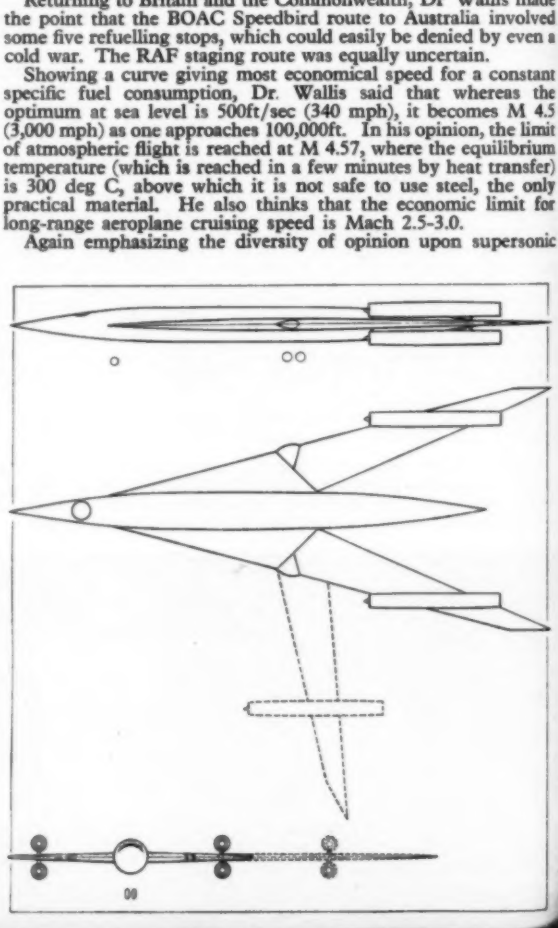
Returning to Britain and the Commonwealth, Dr Wallis made the point that the BOAC Speedbird route to Australia involved some five refuelling stops, which could easily be denied by even a cold war. The RAF staging route was equally uncertain.

Showing a curve giving most economical speed for a constant specific fuel consumption, Dr. Wallis said that whereas the optimum at sea level is 500ft/sec (340 mph), it becomes M 4.5 (3,000 mph) as one approaches 100,000ft. In his opinion, the limit of atmospheric flight is reached at M 4.57, where the equilibrium temperature (which is reached in a few minutes by heat transfer) is 300 deg C, above which it is not safe to use steel, the only practical material. He also thinks that the economic limit for long-range aeroplane cruising speed is Mach 2.5-3.0.

Again emphasizing the diversity of opinion upon supersonic

These drawings indicate the general configuration of a passenger-transport application of the principle. In the sketch below may be seen aft-facing tourist seating, wing tankage and a retractable flight deck





Several years ago Vickers conducted free-flight trials of variable-sweep test vehicles operated from a trolley on the airfield at Predannack, Cornwall. These photographs are taken from a 16mm colour film which is the only record to have been passed for publication

shapes, he showed plan views of the podded delta-wing Hustler ("which can fly at Mach 2 for a *very* short time"), the cancelled Avro canard bomber and a "RAE bomber" layout. (This last was the conventional missile-like design with engine pods on the tips of tiny straight wings illustrated by Sir Arnold Hall in a lecture four or five years ago.—J.H.S.) Indecision in layout, said Dr Wallis, is because people are trying to make the wrong sort of aeroplane altogether.

The right way to achieve high supersonic L/D is to use a slender delta, so that every part lies behind the high-density air of the Mach cone, and to cut away the backside—which is almost useless for lift but contributes much drag because of the separated flow in supersonic flight. It is not surprising that nobody had thought of using it before, since it would be impossible to take off or land without a 20ft high undercarriage.

Dr Wallis then showed slides and films of the "Swallow" and its wartime forerunner the variable-sweep "Wild Goose," both of which were flown as large models from Predannack Aerodrome near the Lizard.

The "Wild Goose" project was a laminar-flow body, a slender ovoid with variable-incidence wings set well aft and a highly swept fin, which was launched at 100 mph from a carriage with a swivelling head to cater for cross winds. Co-ordinated and differential changes of sweepback provided three-axis control. There was no autopilot. The system of radio pilotage was curious, with a "pitch (height) pilot" at the end of the runway and a broadside "roll pilot." It was, said Dr Wallis, difficult to keep the clean aircraft within the aerodrome perimeter—a Security requirement. Perhaps the most surprising feature of the "Wild Goose" film was the steadiness of the flight (one circuit was shown from a camera under the belly) since the pilot, as much as two miles away, had to recognize attitude changes through binoculars and so he tended to over-correct. There was no sign of slithery, yawing turns, which might have been expected from the unconventional method of modifying the forces of equilibrium.

Association of ideas connected the early project with variable sweepback for control, to the solution of the low-speed problems of the cut-out delta for lowest drag at high supersonic speeds.

By a sadly human slip-up the "Swallow" model was lost on its first flight; because, in the excitement of the moment, the pitch pilot forgot to switch off, so that the roll pilot could not gain control to bring the model into the circuit and it flew out into the English Channel. It should have floated for some time, but the coastguards said the tide would drift north, whereas the Channel current must have taken it south, for it was never seen again. Shortly afterwards, the Ministry of Supply, having spent well under a million on the project decided "enough of this nonsense" and support was withdrawn. (One understands that the project, although dropped in May 1957, has again been under consideration since February last with substantial financial support from NASA.—J.H.S.)

This free-flight subsonic "Swallow," apparently of about 30ft span, was powered by two small rockets and had tip fins and elevons. The film showed that it took off at high incidence necessary to obtain the lift contribution from the triangular body/wing, in addition to that of the main surfaces, the "swallowtails," which were set approximately normal to the centreline. Having climbed to a moderate height, the model assumed a slightly nose-up position for level flight. It was markedly steady and, particularly since the consumption of rocket fuel would have modified its weight considerably and rapidly, it is apparent that sufficient pitch stability is obtainable from the lift of the delta portion of the surface, while the oblique leading edges and general side area satisfy roll and yaw needs. The high aspect ratio of the wings in the forward position would give low induced drag and high take-off lift coefficients without flaps.

Supersonic models of the "Swallow" have been successfully flown, but permission to show RAE films of these was not forthcoming.

To get an idea of proportions, the seemingly slender swallowtails of the demonstration model at the lecture appeared to have a thickness ratio of about 15 per cent (structurally) in the forward position, which must have been reduced to something like 4 per cent (aerodynamically) in the line of flight when swept at about 80°. Thus there is no lack of structural depth to give strength in bending, while the narrow chord must keep torsional loads low.

In the "Swallow," wing sweep is co-ordinated and not used for flying control, the greatest problem being to maintain a steady c.g./c.p. relationship during the geometrical changes. One would expect the aeroplane to accelerate automatically as the wings move back and reduce both frontal area and wave drag, so that it would probably chase its M_{crit}, as this value rose with the increasing sweepback. The wing pivots, which are obviously the key secret of Dr Wallis's exceptional mechanical genius are, he says, "something like that used for training a gun." This suggests a fulcrum and lever, possibly with an arcuate (irreversible) rack-and-pinion.

One slide showed fuel tanks in the greater part of the swallowtails and along each flank of the body/wing. Dr Wallis said that the engine nacelles were placed far out as an aid to the c.g. problem—the c.p. moves aft with the sweepback angle and there must be a compensating rearward shift of weight. The engines have to be swivelled to maintain them in the line of flight and from this point "you may as well make them tiltable in pitch as well so that they act as elevators, ailerons and rudders." The areas of the twin nacelles are large and they evidently act aerodynamically, possibly with a little assistance from the deflected jet thrust lines. The nacelles suggest moderate size afterburning turbojets, pivoted well aft so that the weight of the engines can act as mass balances. The pylons of the nacelles are vee-shaped, the apices being next to the wing surface, to give clearance for movements in pitch. One would imagine that the problems of rigidity and suppression of feedback and flutter of the all-ways moving nacelles would be considerable even with power actuation, but Dr Wallis thrives on mechanical problems! Control of the nacelles as aerodynamic surfaces would be from conventional stick and rudder pedals.

Some changes from the original layout drawings are noticeable in the demonstration model. Most marked is the downward curve of the nose to meet the rising airflow produced by the wing lift.

On each side of the body/wing are two long strakes, just about where one would expect the main wheels to be. Published results of tunnel tests on narrow deltas mention severe vortex separation at high incidence and these strakes may be fences.

There is also a small tail projecting aft from the centreline, which one might guess contains a precautionary ground bumper rather than having any aerodynamic significance. One is strengthened in this surmise by Dr Wallis's words when explaining how the original laminar-flow fuselage of the "Wild Goose" came to be flattened into a narrow delta body/wing: "All wetted surfaces produce drag, therefore flatten the fuselage and cut out the tail."

A supersonic aeroplane of this type would have a wing loading of about 40lb/sq ft, not 100lb/sq ft, and would take off at 100 mph in two or three hundred yards. In conversation, Dr Wallis referred to a new Ministry of Aviation design contract for a 50,000lb naval version, possibly with Bristol Siddeley Orpheus engines, which would be able to patrol subsonically for hours with its wings spread and accelerate rapidly to high supersonic speed as its wings went back. He thought that such military development was essential for the financing and pioneering of a revolutionary project. A 60-passenger long-range airliner would weigh about 100,000lb, would have a span (spread) of 130ft and a similar overall length with the wings swept.

A rather controversial statement is that it would be possible to operate a daily return service to Australia with one Swallow—flying time for the return flight would be about 10 hours.

Dr Wallis's closing words to his young audience were undoubtedly the text of his own career: "In the course of your work you will make many friends, but you will also meet many obstructors—then never, *never* give up!" J.H.S.

The New Year Honours

CIVIL-LIST AWARDS IN AVIATION: INDUSTRY, AIRLINES AND THE MINISTRIES

THOUGH a fair cross-section of the aeronautical scene is reflected in the New Year Honours List, announced last week, there is the familiar—and in our view disappointing—lack of recognition of the work of test pilots. Nevertheless, news of several awards, particularly in the industry, will give general satisfaction: for example, the barony for Sir George Nelson, chairman of the English Electric Co Ltd, and the appointment of Rear Admiral Sir Matthew Slattery, chairman and managing director of Short Brothers & Harland Ltd, as KBE; and if the names of test pilots are lacking, there is at least recognition for an industrialist whose products have helped to save their lives—Capt Cyril Turner, the managing director of Irving Air Chute of Great Britain Ltd.

Notable among the numerous Civil Service awards is that of CBE to P. G. Tweedie, Chief Inspector of Accidents (Civil Aviation), MoA, and among the honours for airline personnel is the appointment as OBE of Capt T. B. Stoney, BOAC's Boeing 707 flight manager.

Sterling work by the humbler ranks is reflected in the award of the British Empire Medal to a dozen-odd men occupied in various branches of aviation activity.

Service honours and awards are given in detail on page 61 of this issue.

Left to right: Sir George Nelson (Baron), Rear Admiral Sir Matthew Slattery (KBE), Capt C. C. T. Turner (CBE)

BARON

Sir George Nelson, chairman, English Electric Co Ltd.

PRIVY COUNCILLOR

J. D. Profumo, Minister of State for Foreign Affairs (Parliamentary Secretary, MCA, 1952-53; Joint Parliamentary Secretary, MTCA, 1953-57).

COMPANION OF HONOUR

A. T. Lennox-Boyd MP (Parliamentary Secretary, MAP, 1943-45; Minister of Transport and Civil Aviation, 1952-54).

BARONET

G. R. H. Nugent, MP (Joint Parliamentary Secretary, MTCA, 1957-59).

KNIGHTS BACHELOR

J. F. Lockwood, chairman, EMI Ltd; Prof H. S. W. Massey, Quain Professor of Physics, University College, London (chairman of British National Committee on Space Research); C. Raeburn, chairman, Cyprus Airways; A. B. Waring, chairman and managing director, Joseph Lucas (Industries) Ltd.

ORDER OF THE BATH

KCB

L. J. Dunnett (holder of various senior posts in aviation Ministries from 1937; latterly Deputy Secretary [A], MoS).

CB

R. H. Weir, Director-General, Engine Research and Development, MoA; F. Wood, Assistant Under-Secretary of State, Air Ministry.

ORDER OF THE BRITISH EMPIRE

KBE

Rear Admiral Sir Matthew Slattery, chairman and managing director, Short Brothers and Harland Ltd.

CBE

L. J. Davies, director of research and education, British Thomson-Houston Co Ltd; T. J. O'Leary, senior flying doctor in Queensland of the Royal Flying Doctor Service of Australia; Capt C. C. T. Turner, managing director, Irving Air Chute of Great Britain Ltd; P. G. Tweedie, Chief Inspector of Accidents (Civil Aviation) MoA.

OBE

E. H. Aldis, chief engineer, Qantas Empire Airways, Australia; H. E. Barry, manager, Trade Relations Department, Shell-Mex & BP Ltd; G. E. Bell, senior principal scientific officer, MoA; F. J. Brewin, lately principal inspector, MoA; R. I. Cameron, Assistant Secretary (Finance), Department of Air, Australia; A. W. H. Cole, manager, Communications Division, Marconi's Wireless Telegraph Co Ltd; J. Ellis, Superintending Civil Engineer, lately Air Ministry; J. B. Parry, senior principal psychologist, Air Ministry; Capt T. B. Stoney, flight manager, Boeing 707 Flight, BOAC; A. Symon, manager, sales engineering, Bristol Aircraft Ltd; P. H. Watson, Assistant Director (Engineering), Aircraft Design Requirements, MoA.

MBE

A. Allen, chief development engineer, Cossor Radar & Electronics Ltd; L. F. Archibald, commissioner, Australian Air League; E. L. Bell, tariffs regulations superintendent, BEA; E. J. Brunckhurst, chief maintenance engineer, Trans-Australia Airlines; E. Brown, chief photographer, Air Ministry; S. R. Brown, signals officer, MoA; W. H. Butcher, chairman of committee, No 372 (Barry) Sqn, ATC; A. G. W. Cannon, divisional manufacturing manager, A.E.I. Ltd, Rugby; J. V. Cross, mechanical and electrical engineer, Air Ministry Directorate-General of Works, London Airport; Rev F. H. P. C. de Costobadie, lately official chaplain, RAF Rufforth; L. Evans, senior executive officer, Air Ministry; Miss P. M. Evans, controller of typists, MoA; Capt F. Fisher, chief check and training captain, Trans-Australia Airlines; J. H. Forest, technical manager, Kuwait Airport; R. W. Gale, lately technical adjutant, No 25 Maintenance Unit, RAF Hartlebury; D. S. Graham, in recognition of services as civil aviation liaison officer, Department of Civil Aviation, during royal visits to Australia; J. Hamilton, executive officer, RN Aircraft Yard, Donibristle; D. A. Hewetson, telecommunications technical officer, Ronaldsway Airport, Isle of Man; E. J. Hocking, electrical manager, Vosper Ltd; E. J. Kydd, chief maintenance engineer, Qantas Empire Airways, Australia; H. Lloyd, Black Knight project officer, Saunders-Roe Ltd; E. Piercy, Inspector, Aeronautical Inspection Service, No 28 MU, RAF Harpur Hill; T. B. Powell, senior executive officer, MoA; G. H. Prince, head of apparatus engineering department, Ericsson Telephones Ltd; F. M. Reynolds, senior surveyor, Air Registration Board; Obs Cdr F. Rodgers, Gp Cmdt, No 15 Gp, Royal Observer Corps; T. A. Sawyer-Snelling, line maintenance manager, Mideast Aircraft Service Co, Beirut; B. W. Stearn, higher executive officer, Air Ministry; G. A. Streeter, chairman of committee, No 1254 (Godalming) Sqn, Air Training Corps; G. H. Winn, airport manager, Blackbushe.

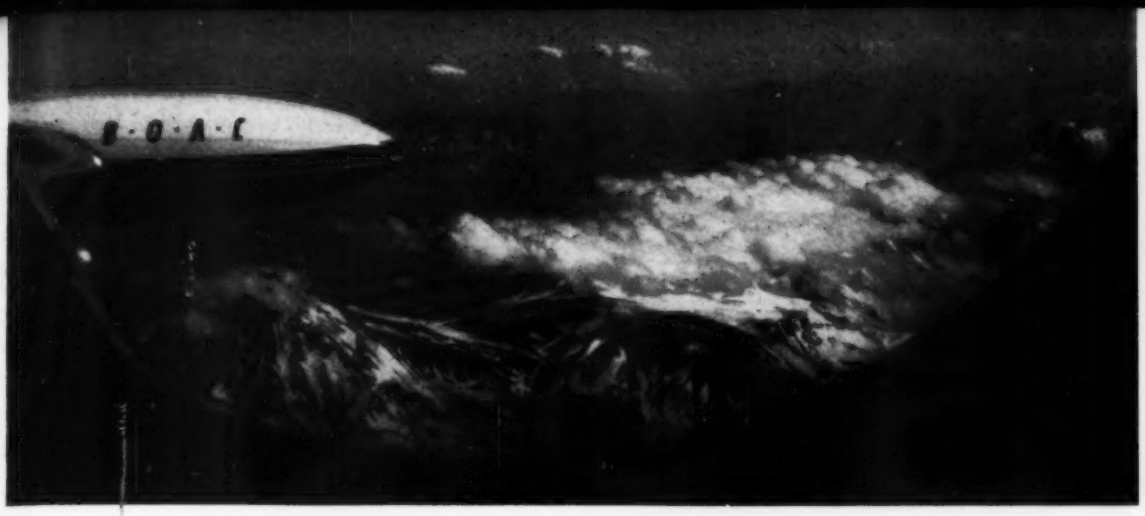
QUEEN'S COMMENDATION FOR VALUABLE SERVICE IN THE AIR

Capt W. M. Jacob, flight superintendent, training, Skyways Ltd; Capt T. McQ. Robertson, managing pilot, Borneo Airways Ltd; Capt J. Woodman, senior capt, first class, Boeing 707 Flight, BOAC.

Left to right: Capt T. B. Stoney (OBE), A. Symon (OBE), Capt J. Woodman (Queen's Commendation)

BRITISH EMPIRE MEDAL

S. Armishaw, senior examiner, Aeronautical Inspection Service, No 99 MU, RAF High Ercall; J. Armitage, Civil Instructor, RAF Technical College, Henlow; L. A. Balmforth, Ch Obs, Post 3/N.1, No 3 Gp, Royal Observer Corps; A. Bishop, clerk of works, RAF Yatesbury; A. C. Dingle, Civ WO, No 24F (W. Cornwall) Sqn, Air Training Corps; G. H. Green, mechanical examiner, MoA; W. Greenlees, Civ WO, No 1036 (Bury) Sqn, Air Training Corps; H. E. Hammond, engineer technician (foreman), Armament Research and Development Establishment, MoA; L. L. Munday, Ch Obs, Post 3/E.3, No 3 Gp, Royal Observer Corps; R. J. Pitman, foreman of trades, No 12 MU, RAF Kirkbride; A. G. Shahabuddin, works supervisor, RAF Riyan, Arabian Peninsula; G. H. N. Thomas, chief inspector, War Department Constabulary, MoA; C. E. Thurgood, premises officer, BOAC, London Airport.



South American Rentrée

BOAC RETURNS TO THE SOUTH ATLANTIC

By ALASTAIR PUGH

IN offices with views as diverse as London's rain-washed roofs, Recife's palm-fringed waterfront, Buenos Aires' wide avenues, or the snow-tipped mountains which look down upon lofty, heat-soaked sky-scrapers of Santiago, final preparations are being made for the re-open-ing of BOAC services to South America. After a lapse of five years—in which the traffic over this route has almost doubled, yet only a caretaker staff has remained to safeguard BOAC's interests—the task of becoming successfully re-established ahead of other jet competition is enormous. Seemingly endless political arrangements have had to be negotiated, there has been a thorough new market survey, station staffs have been expanded and managers appointed, and finally there have been three pre-service Comet proving flights down the route. This article, written after the third of these 14,000-mile flights from London to Santiago de Chile and back, discusses the commercial background to BOAC's return to South America.

"MEANWHILE, the immediate challenge of the Comet's loss had to be met by rapid improvizations; the utilization of aircraft in the fleet stepped up; Hermes were recalled to service for a brief period; and the corporation's Commonwealth partners provided an increased share of the capacity on the Australian and South African routes. The South American services had to be temporarily suspended."

That, in the terse phrases of the BOAC annual report for the year ended March 31, 1955, was the situation nearly six years ago; the Comet had been withdrawn from service in April 1954 and as a direct result the twice-weekly first-class Argonaut services on the South Atlantic route to Santiago ceased shortly afterwards, so that the hard-pressed corporation could find additional capacity for its other services.

Now—as from January 25—BOAC is back on its traditional route to the South Atlantic, and back with the finest equipment in its fleets—the de Havilland Comet 4. What are the corporation's chances of achieving commercial success on the route across the equator from Dakar to Brazil, down to Montevideo on the sun-splashed shores of Uruguay, and west to Buenos Aires and across the high Andes to Santiago? And why has January 1960 been chosen as the date for re-introducing this particular service?

Neither of these questions can be fairly answered in a word. The South Atlantic route is one of the most difficult in the world on which to operate at a profit, and to judge the wisdom or otherwise of the corporation's decision a good number of facts and trends must be marshalled and weighed in the balance. The obvious view is that with nine carriers already on this route, offering low-frequency services and achieving generally inadequate load factors, it must be commercial folly for BOAC to come back to a route that was the first to be dropped during the difficult period of 1954. This is the view forcibly expressed in the December issue of *The Log*, the journal of the British Air Line Pilots' Association:—

"It would be interesting to know from the start [Mr Sandys'] opinion on the resumption of BOAC services to Rio and Santiago. This is an expansion: Britain's showiest aircraft will try to skim the cream of traffic down to South America; a good boost for British trade. But absolutely certain to lose money for BOAC over the next five years. Nor is it likely that a more efficient airline would make any profit on this run; it is a cut-throat route with already more seats offered for sale than there are passengers to fill them."

Yet BOAC do not agree, and in the last analysis it is the cor-

Comparison of the South Atlantic routes operated by BSAA in 1948 (left) and by BOAC in 1960. In the heading: the Andes crossing

Journey's end is Santiago, reached after a descent from the snowy Andes

South American Rentrée . . .

poration who have the final word in whether they operate the service or not. It must be said at once that, in spite of such gloomy prognostications about the chances of economic success, BOAC have always intended to return to South America as soon as the aircraft capacity became available: and in September 1957 Sir Gerard d'Erlanger, their chairman, gave the promise that his airline would return to South America "not later than the spring of 1960, provided the financial position makes it possible." Whether resumption of a service with such a difficult economy is justified by the heavy loss recorded in the 1958-59 annual report may be open to question; but before examining in closer detail the corporation's case for re-starting services within the arbitrary time limit of spring this year it is worth taking a closer look at traffic and capacity over the South Atlantic.

Within the keenly contested framework of this route, nine carriers are already operating: Aerolineas Argentinas, Air France, Alitalia, Iberia, KLM, Lufthansa, Panair do Brasil, SAS and Swissair. BOAC will make the number ten. The tables below show the results for each of these carriers during the "average" months of March and September in 1958, and the table opposite indicates the capacity offered by each carrier in the period winter 1959 and their departure and destination points for the actual overwater crossing. And although these figures can be used only to deduce the traffic flows to a first order of accuracy, they do give a working basis for measuring the challenge with which the corporation are faced on the South Atlantic route. During the five years in which BOAC have been absent from South America traffic has almost doubled, but the corporation's initial offering with two Comet services a week will not be much greater in capacity terms than it was in 1954, when the same routes were flown with DC-4M Argonauts.

Comparative results for the years 1958 and 1959 are:—

1958	Seats available over the year	121,750
	Passengers carried	61,800
	Seats available per week	2,340
	Passengers carried per week	1,180
	Average load-factor	50 per cent
	Average services per week	21.5
	Number of carriers	9
1959-60	Average seats available per week	2,630 (880 first, 1,750 tourist)
	Average services per week	23
	Additional capacity offered over 1958	12 per cent
	Number of carriers	10

The figures for winter 1959 include the two services a week about to be operated by the corporation and which represent about 8 per cent of the total capacity offered on this route. What will happen in the next two years? It seems almost certain that capacity will be increased at a greater rate than the route has ever previously experienced, but because there will be very little corresponding increase in *frequency*—a much more successful generator of traffic than rows and rows of empty seats—it seems fairly certain that as the big jets are introduced already-slender load factors must remain static or decline.

In 1960-61 the South Atlantic line-up of weekly services could be:—

Aerolineas Argentinas		2 (Comet 4s)
BOAC		3 (Comet 4s)
Air France	Air Union	2 (Boeing 707s)
Alitalia	Air Union	2 (DC-8s)
Lufthansa	Air Union	2 (Boeing 720s)
Panair do Brasil		2 (DC-8s)
Iberia		1 (DC-8)
KLM		2 (DC-8s)
SAS		2 (DC-8s or Convair 600s)
Swissair		2 (DC-8s or Convair 600s)

This represents a total of not far short of 5,000 seats per week—very nearly double the present capacity. Of course, no airline would schedule capacity at a frequency that results in totally uneconomic load factors, even for reasons of national prestige on an intercontinental route. If traffic cannot be found to fill about the same proportion of seats as at present, the superfluous capacity will be withdrawn or will not be offered. Here it is significant that three of the Air Union carriers operate over the South Atlantic (it has been suggested that the germ of the Air Union idea sprang from discussions between these carriers about this particular route) and it is conceivable that by 1961 Air France, Alitalia and Lufthansa may rationalize their services to the extent of operating to South America under the Air Union flag. A similar arrangement is possible between SAS and Swissair, who can in any case be expected to adjust their schedules to the best advantage of both, and it might be equally logical for BOAC to conclude the pooling agreement for a combined Comet operation already under review with Aerolineas Argentinas. If these measures alone are insufficient to reduce total capacity to near-economic proportions, the Argentinian and Brazilian governments might well attempt to protect their national carriers' interests by limiting frequencies through adjustment of bilateral agreements. And although faster services may then be offered by the US-jet operators, the smaller size of the Comet should be to BOAC's and AA's competitive advantage in offering more frequent schedules—a familiar argument for the aircraft which applies particularly to the South Atlantic route. BOAC intend to take early advantage of it by stepping up services to three a week as soon as possible.

Aerolineas Argentinas, the first jet operators on the South Atlantic, claim a very successful initial year with the Comet. They increased their revenue by 85 per cent in the first two months (May and June 1959) of Comet operation and carried 31 per cent

SCHEDULED SERVICES

(South Atlantic Traffic Flows, **March 1958** (Source, ICAO Digest of Statistics)

WESTBOUND

Carrier	Seats available	Pass. carried	Pass. load-factor (%)	Flights	Route
Air France	488	341	70	9	Dakar-Rio
Aerolineas Argentinas	396	184	47	9	Dakar-Natal
Swissair	477	264	56	9	Lisbon-Recife
Panair do Brasil	660	201	30	11	Lisbon-Recife
Panair do Brasil	950	404	44	17	Dakar-Rio/Recife
Iberia	296	72	24	4	Dakar-Rio
Alitalia	459	198	43	9	Sal Island-Rio
KLM	605	223	39	11	Lisbon-Recife
SAS	459	223	49	9	Lisbon-Recife
Lufthansa	526	185	27	10	Dakar-Rio
Monthly totals	5,316	2,295	43	98	

EASTBOUND

Air France	477	334	70	9	Rio-Dakar
Aerolineas Argentinas	398	239	35	9	Natal-Dakar
Swissair	477	305	71	9	Recife-Lisbon
Panair do Brasil	703	255	36	13	Recife-Dakar
Panair do Brasil	960	406	41	16	Raio-Dakar
Iberia	296	33	28	4	Rio-Dakar
Alitalia	357	168	48	7	Rio-Sal Island
KLM	605	230	37	11	Recife-Dakar
SAS	408	228	56	8	Recife-Lisbon
Lufthansa	470	185	49	9	Rio-Dakar
Monthly totals	5,151	2,383	47	95	

(South Atlantic Traffic Flows, **September 1958** (Source, ICAO Digest of Statistics)

WESTBOUND

Carrier	Seats available	Pass. carried	Pass. load-factor (%)	Flights	Route
Air France	780	306	52	13	Dakar-Rio
Aerolineas Argentinas	384	286	77	8	Dakar-Natal
Swissair	424	254	60	8	Lisbon-Recife
Panair do Brasil	477	265	56	9	Dakar-Recife
Panair do Brasil	1,020	652	64	17	Lisbon-Recife
Iberia	370	112	30	5	Dakar-Rio
Alitalia	357	236	67	7	Sal Island-Rio
KLM	440	242	54	8	Lisbon-Recife
SAS	459	285	62	9	Lisbon-Recife
Lufthansa	195	106	54	4	Dakar-Rio
Monthly totals	4,906	2,744	58	88	

EASTBOUND

Air France	720	416	58	12	Rio-Dakar
Aerolineas Argentinas	433	370	89	9	Natal-Dakar
Swissair	424	417	84	8	Recife-Lisbon
Panair do Brasil	477	159	33	9	Recife-Dakar
Panair do Brasil	1,080	644	60	18	Recife-Lisbon
Iberia	370	128	35	5	Rio-Las Palmes
Alitalia	357	204	56	7	Rio-Sal Island
KLM	385	211	52	7	Recife-Lisbon
SAS	459	173	38	9	Recife-Lisbon
Lufthansa	195	151	77	4	Rio-Dakar
Monthly totals	4,900	2,873	58	88	

more passengers—the inference being that more first-class seats were offered than hitherto. In their Comet 4 the ratio is 24 first to 43 tourist, a denser configuration than that adopted by BOAC, although for both carriers 61 seats filled for the moment represents 100 per cent revenue load-factor. (In BOAC's Comet this is because at the start of services supernumerary crews undergoing route training will be carried; in the Argentinian Comets the configuration is identical with that used on overland services.) The number of seats could eventually be increased to 68, although most tourist-class proving flight passengers would agree that they would prefer not to see an extra row of tourist seats added to the present layout.

In BOAC's case these proportions between first- and tourist-class seats have been derived from the arrangement most suited to the aircraft and from the study of market conditions in South America undertaken by the Corporation in June; inevitably they represent a compromise that will have to be assessed during the first months of service.

Seats per week, one way on South Atlantic, Winter 1959

Airline	Services	First-class	Tourist	Seats per a/c	Seats p.w.	Crossing
BOAC ...	2 Comet†	20	41	61	122	Dakar-Recife
Aerolineas Argentinas	2 Comet	24	43	67	134	Dakar-Recife
Swissair ...	2 DC-7C	26	29	55	110	Dakar-Rio
Air France ...	3 L.1049G	20*	34*	54	162	Dakar-Rio
Panair do Brasil ...	2 DC-6C	12	35	47	94	Dakar-Recife
	3 DC-7C	12	48	60	180	Lisbon-Recife
Iberia ...	1 L.1049G	16	55	71	71	Ilha do Sal-Rio
Alitalia ...	2 DC-6B	12	51	63	126	Ilha do Sal-Recife
KLM	2 DC-7C	24	31	55	110	Lisbon-Rio
SAS	2 DC-7C	24	25	49	98	Lisbon-Recife
Lufthansa ...	2 L.1049G	22**	33**	55	110	Dakar-Rio
Weekly totals	23	440	877	—	1,317	
Average seats	—	19	38	57	—	

*Air France flights to Buenos Aires and Sao Paulo only; to Lima Air France offer 12 first-class, 44 tourist + 4 beds.
**Configuration is changed to suit bookings.
†Later 3 services weekly

Who travels? In studying traffic and travellers from South America it is impossible to categorize so big a market. BOAC serve Brazil, Uruguay, Argentina and Chile, each of which has different affiliations to Europe, contrasting interests and standards of living, and different political, cultural and economic backgrounds. But undoubtedly the most important markets for BOAC at the moment are Rio de Janeiro and Sao Paulo in Brazil and Buenos Aires in Argentina. These are the great business centres of the South American continent and it is the carriage of business traffic to Europe and to the United Kingdom which must be the mainstay of the corporation's year-round load factor. It represents perhaps 30 per cent of the total uplift—just about the proportion, incidentally, of first-class seats in the Comet. Of the businesses in these cities some are concerned with the production of motor cars under licence (Fiat, Volkswagen, BMC and Renault are active in South America), and the interchange of executives and technicians between the South American countries and the United Kingdom, German, French and Italian engineering industries account for an appreciable proportion of the total traffic flow. But production of cars is only part of the ebullient South American industry, so it is axiomatic that the better the trade relations between the United Kingdom and South American countries the better our national carrier can expect to do. The remaining and largest category of travellers can be classified as those whose primary interest is tourism, sport, or the religious or cultural affiliations of South America with other parts of the world—for example the close Brazilian connection with Portugal or the home ties of the half-million Japanese who also live in that country.

There is also a tradition among the more wealthy South Americans—just as there is among many inhabitants of the United States—that Europe should be visited at least once during the course of a lifetime. There is a major task here for the British Travel and Holidays Association—who have offices in Buenos Aires and are represented in Rio—to encourage travellers to include London in their European itinerary; their campaign will now be mounting for the peak travel season of late April to August and their effort should be given impetus by the introduction of BOAC's services this January.

But this (as BOAC's traffic manager at Rio and Sao Paulo was at pains to point out to the writer) is probably as far as generalizations can go. "Brazil," he explained, "is a special case, because here there is no middle class." The majority of the traffic consists of businessmen, and if the corporation had only Rio and Sao Paulo to consider the service might well take on a different aspect, with greater emphasis on high-speed, first-class travel.

One other great market remains relatively untapped—the considerable number of passengers who travel to and from the eastern South American seaboard by sea. Many South American tourists, it is claimed, save hard to travel to Europe or the United States by air and then return by sea, bringing with them sufficient purchases to recoup part of the cost of their journey. These are travellers who would benefit from economy-class travel, but as yet they are insufficiently numerous for South Atlantic promotional fares to have been seriously considered—this in spite of the Great South American Rate War in which discounts of up to 50 per cent were offered.

Behind the Panagra DC-4 is Buenos Aires' imposing terminal building

Earlier in this article the two questions posed were: Can BOAC hope to operate its South Atlantic services at a profit? And why has this point in time been chosen for their re-introduction after a lapse of five years? Having brushed in the the broad background to this vast South American canvas, we might now examine in greater detail what the corporation has to offer on these routes, and what it may hope to gain.

As already remarked upon, the schedule which will begin this month offers very little increase in capacity in a market that has expanded quite appreciably. In the past five-and-a-half years a steady effort has been made in keeping the name of BOAC before the South American public by operating off-line sales offices and by keeping up contacts and a flow of information from staff serving in South America during the period when there were no operations. Small though this effort has been in competition with the sales campaigns mounted by the other airlines on this competitive route, BOAC claim—with a good measure of justification—that the public image of the corporation has remained favourable. But it must be added that on-the-spot confidence in what has been achieved over the past five years varies considerably, and it is probably true to say that the two most pro-British, pro-BOAC countries are Uruguay and Chile—unfortunately also the smallest generators of traffic.

To try to get the profit-potential of this service in perspective a little arithmetic shows that the average sector-length on BOAC's South Atlantic service is the surprisingly low figure of 863 n.m., since two ultra-short stages are included—Madrid to Lisbon (over which there are no traffic rights) and from Montevideo along the River Plate to Buenos Aires. Even the longest sector—Dakar to Recife—is only 1,725 n.m. Making some rather broad assumptions about the ratio of BOAC's direct to indirect operating costs, the cost of Comet operation over this hypothetical stage, and Comet earnings on the South American route (about £2.25 per aircraft n.m. on 100 per cent load factor) it seems that total costs calculated on a basis of twice ATA formula direct operating costs *could* be covered on load factors of about 50 per cent, although this must be factored to bring it into line with BOAC's actual operating costs (which are believed to be somewhat higher) and by the promotional and establishment costs inherent in returning to the South American route. Initially these costs could well demand a break-even load factor that would be out of reach over any sustained period.

Apart from January 1960 being about the earliest date that BOAC have had the capacity available to resume this service, there are two other powerful reasons why this period should be chosen. From this summer, the big jets are to be introduced on the South American routes by competitive carriers, and it is

(*continued on page 57*)

Measure of the Comet's prestige in South America: no Chilean airline operates the Comet, but it features nevertheless on the nation's stamps

Missiles and Spaceflight

This three-stage HTV-2 rocket built by Curtiss-Wright was stated last month to have achieved a velocity of almost Mach 10 within 10sec of launching. The test firing took place on December 16 from Holloman Air Force Base, New Mexico

CANADIAN-US LAUNCHING

A 48lb scientific payload was launched by means of a four-stage Javelin sounding rocket to a height of 560 miles from Wallops Island, Virginia, on December 22, as part of a joint experiment carried out by the United States and Canada. The test objectives were (1) to measure the intensity of galactic noise and (2) to determine the performance of the X248 rocket at high altitude. The first of these tests was devised by the Advanced Research Telecommunications Establishment of Ottawa; while the second formed part of the space sciences programme of the US National Aeronautics and Space Administration.

The launching vehicle comprised an Honest John, two Nikes, and the X248. Performance data on this fourth-stage engine (which will form the third stage of the NASA Delta vehicle) were telemetered to ground stations at Wallops; Cape Hatteras, North Carolina; and Cape Canaveral. Take-off weight of the vehicle was about 7,000lb and the payload fell in the Atlantic some 600 miles from Wallops Island.

MORE NEWS OF TITAN

Further information has come to hand on the fundamental cause of the most recent failure of a Titan ICBM. Our first round-up on this topic was published in our issue of December 25.

The last failure, on December 12, destroyed the first of the Titan C series, with second-stage propulsion and the new Avco ablative nosecone. The malfunction which triggered the command destruct system has been traced to structural deflection engendered by exceedingly high local accelerations, of very small amplitude, resulting from the elasticity of the airframe and the complex forces acting upon it at the moment of lift-off. A solution appears to have been effected by relocating units of the destruct system on more rigid portions of the missile body and by employing twin relays so disposed that malfunction of either alone cannot trigger the system and that any single force on the airframe cannot cause both relays to close.

In view of the fact that Martin's Denver Division have conducted on Titan what is probably the most thorough static-test programme yet carried through on any ballistic vehicle, this appalling explosion at the moment of launching serves to emphasize the type of unforeseen malfunction which may arise. Solution of the problem is rendered more acutely difficult by the fact that triggering of the destruct system—particularly when the missile's tanks are filled completely, as they are at lift-off—causes such catastrophic demolition as to make it very difficult to determine what actually happened. It is a remarkable fact that Martin's pads at Cape Canaveral are still able to accept new rounds, and at least two (B-7A, the last of the B series, and another C) are due to be launched as we go to Press.

US IMPORTS COBRAS

The American electronics firm of Daystrom Inc has obtained exclusive rights for the sale and manufacture of the Cobra anti-tank missile in the USA. Originally developed by Bölkow Entwicklungen in Munich, the Cobra is a typical wire-guided cruciform-winged missile larger than the Vickers Vigilant but smaller than the SS.10. Brief details were given in our special issue of November 6 last. The US Marine Corps has ordered 100 Cobras, which will be evaluated at Camp Pendleton, California, beginning this month. According to the Daystrom company the missile should cost under $1,000 in quantity production.

ROCKET EFFECTIVENESS

A twenty-five-fold improvement in the ratio of take-off weight to payload weight should be accomplished in the US space booster programme in the period between now and completion of the Centaur project. This was stated by Dr Homer J. Stewart, director of the NASA office of programme planning and evaluation, in a speech in Washington last month.

Describing the current use of interim vehicles and the future planning for more-versatile and more-powerful long-term boosters, and commenting that both of these activities were essential, Dr Stewart said "The largest scientific payloads we have up to this date placed in orbit are the 90lb Explorer 7 payload, launched by a Juno 2, and the 142lb Explorer 6 payload launched by a Thor-Able. Somewhat larger payloads have been launched in the Discoverer series; however, these somewhat larger payloads are possible only in very low-perigee, short-lived orbits which are not well-suited for most space science experiments.

"One way to compare the effectiveness of these interim configurations with more appropriately designed equipment is to note the ratio of take-off weight to payload weight. For the 142lb Explorer 6, the ratio is about 750:1. A properly proportioned three-stage vehicle using our current level of technology, the same as that used in any of our large military vehicles, would have a take-off weight to payload weight ratio of 40 or 50:1; that is, our present exploitation of the booster vehicle in satellite orbits is less than 10 per cent effective. Similarly, the Pioneer 4 had a net payload weight of only 12lb for a ratio of about 8,000:1. Again, a properly proportioned vehicle would produce a ratio of about 150 or 200:1, and our efficiency of exploitation, in this case, is thus less than 3 per cent.

"These ratios show clearly that our present operations are not primarily limited by the size of our first-stage booster rockets—even though in the long run we require substantially larger booster rockets. Our present primary limitation lies in the fact that we do not have the appropriately scaled upper-stage rockets to exploit efficiently our large military booster rockets as first-stage launching vehicles.

"We are now developing the Agena and the Centaur upper-stage rockets to permit an efficient exploitation of our IRBM and ICBM boosters. For comparison it may be of interest to note that the high-energy propellant development used in Centaur is expected to produce a payload capacity in an orbit corresponding to a ratio of take-off weight to payload weight of about 30:1, twenty-five times as effective an exploitation as our best effort to date".

Prof H. S. W. Massey, chairman of the British National Committee on Space Research, is visiting the USA this month to arrange final details of the Anglo-American programme for collaboration in satellite research. British instruments are to be carried in an American satellite casing which will be launched by means of a Scout solid-fuel rocket.

Brig-Gen Von Kann, director of US Army aviation, said last month that SS 11s fired from low-flying helicopters had obtained "up to 11 direct hits out of 14 shots at tank targets 1,000yd away."

Rocket and satellite instrumentation is to be the subject of a one-day symposium in London next September organized by the Society of Instrument Technology in conjunction with the British Interplanetary Society. Among the proposed papers will be one on the scientific investigations planned for the British space programme, and another will describe a design study of a communications satellite.

Reduced cost and greater lethality are claimed by the Martin Company's Orlando Division for the revised ASM-N-7a version of Bullpup. The US Navy have announced that the 7a will incorporate a more effective warhead, a pre-packaged liquid motor which increases the range of temperatures over which the missile can be stored and fired, and a rationalized guidance system with more easily produced components and slightly greater range.

Soviet preparations for flights to Mars and Venus have already begun, according to academician Vladimir Kotelnikov. The main difficulty as regards electronics, he said, was that the power of radio transmitters would have to be further reduced because they would need to be provided with energy for much longer periods of time, and the distances over which signals would have to be sent would increase by a factor of approximately 1,000.

Weather maps were prepared by the GEC missile and space vehicle department from photographs obtained during a recent Atlas nosecone flight "to show how a satellite might supplement conventional weather observations." A mosaic of individual photographs was prepared, from which scientists were able to interpret a number of large-scale meteorological features in the mid-Atlantic area. The Atlas cone reached a height of 805 miles; a Thor cone from which similar photographs were earlier taken at 345 miles was said to have disclosed a hurricane in its early stages which would not normally have been detected from the Earth's surface.

What Course for the Industry?

No 2 of the series: FRANK BESWICK interviews PETER MASEFIELD

BY coincidence it was on the day of the announcement that the Bristol Aircraft Type 188 supersonic machine would be flying in 1960 that I put to Peter Masefield, managing director of the company and this year's president of the Royal Aeronautical Society, the question: *"Must we accept the necessity for an overall contraction of the British aircraft industry?"* His reply, as is usual from him, was crisp and factual:—

"Quite clearly, yes. Military requirements over the past few years have accounted for some 85 per cent of the industry's total output and the prospect is that this military - civil proportion will in future be reversed. Even with the assured vast expansion of civil air transport it will be some time before the 85 per cent civil production equals in volume the present military business."

"How would you visualize the contraction affecting the industry — evenly all round, or will it be very much a selective affair?"

"What we *ought* to do is to have a good look at the operation as a whole, including the potential market, and then decide what is most suitable for our skills and techniques. If we can settle what the market will need over a period of years then the task would be to match our industry accordingly. It is terribly important to get a long-term plan in proper perspective. Manned strategic aircraft are going, but there will be the medium-range jets, the executive-type aircraft (for which there is a huge potential), the tactical military machines, and then a varied demand for such things as freighters and car ferries."

"Is a plan of this kind going to involve further rationalization?"

"Just now, of course, that is a key question—and a delicate one. What one *can* say is that we must decide how best we can make the things which we decide to go in for. It would be silly, for example, to have a situation in which we left firms with the responsibility of making transport aircraft if they had no previous successful experience in this particular field. There *are* firms with experience in each of these different fields, and they should form the nucleus."

"If further rationalization is necessary ought it to be a complete merger, or some looser form of association? Would technical advantages not favour the idea of the merger?"

"Technically, a merger does not necessarily help at all—though here I am speaking about airframes and not engines. The other form of association would be an extension of the sub-contracting principle."

"But there must be some size below which it is not economic to design and develop an airframe?"

"Yes, and that pinpoints the problem. Merging to do what? If a supersonic airliner was the objective then the unit of development and production could scarcely be too big—provided, of course, the organization has the proper background of experience. With executive aircraft one might almost say the smaller the unit the better, within reason. Then there is the problem of the medium transport—that is one that ought to be kept out of the hair of those responsible for the supersonic; on the other hand, it requires an organization bigger than for the executive aircraft. In short, if you ask me about the optimum size of a manufacturing unit you must first tell me what it is going to manufacture."

"What about the problem of the supersonic transport? Do you think that we have the resources to take it on?"

"From a technical point of view, yes. But the problem is not so much one of technical difficulties, though they may be severe enough. The big questions concern the very heavy development expenses and the limited market. If we are confined to BOAC as our home customer and such export sales as we can later attract, then the economics of the thing are very doubtful. As I said in the lecture to the Institution of Production Engineers in April of last year, in these circumstances there might well be merit in considering collaboration with the Americans—a joint operation in which we could play a very full part. Certainly we can contribute a good deal from the aerodynamic point of view. And there are other advantages to be gained from building the prototype here in this country."

"Is the State now devoting enough of our resources to aeronautical research? Is the money being spent on the right things?"

"Since our national future depends on technological developments, more spent on research would almost always be worthwhile —not only for direct results but because it could attract, *and retain*, scientists and technologists now tempted to leave us. In the future, no doubt, the problems of supersonic flight will take up a greater proportion of research effort and it is equally reasonable to expect that defence problems will take up less effort. But it is all bound up with national defence policy."

"If the State is going to find it necessary to give assistance in the future, on what basis should it be given?"

"I have always been a prototype chap. I still believe that the Brabazon Committee was the right approach, and it paid off directly and indirectly—remember that the Viscount, Comet and Britannia all sprang from the recommendations of that committee. What it amounts to, therefore, is that we need a decent requirements organization and then to support our faith in market research with fruitful Government research. As for recovery, there is nothing wrong, in my view, with the levy principle, and the Government could recover its advances that way.

"But after the prototype stage there still remains development; that, too, is costly, as the Corporations have been emphasizing recently. With your considerable experience on the operating side how do you think the development costs should be carried in the future?"

"The right course is for the British operators to get right in at the beginning—that means with the development of new types. In this way they get a technical lead—a temporary one possibly, but certainly a valuable lead which also means commercial benefits."

"But is the cost not too heavy for the operators to bear?"

"The cost should be tolerable—I'm not speaking of the supersonic transport, of course, for that is a case apart. And, as I say, the costs would be balanced by advantages. Taking the long view, I would have thought this was the right approach for both constructor and operator; and it is the long-term view which we should now be taking for British aviation."

Cockpit of the Westland Whirlwind used by the BEA helicopter experimental unit for instrument-landing development. The Decca Flight Log and a mounting for VOR or ADF dial are on the coaming. At extreme right are the Zero Reader controls; Decca and Newmark autopilot panels are on the central console. Brackets on the windscreen are for instrument-flying blinds

FLIGHT SYSTEM SURVEY

Towards All-weather Helicopters

THE BEA helicopter unit, based in the old "beehive" terminal building at Gatwick airport, is responsible for some pioneering work in the development of all-weather commercial helicopter operations. Although a Sycamore, a Bell 47G and a 47J and a Whirlwind are operated on charter work of various kinds, another Whirlwind is used purely for development flying. In this aircraft, G-AOCF, a *Flight* representative flew last week with Capt J. W. Reid, flight technical development officer of the unit, and later talked to R. A. Davis, who is in charge of the electronic laboratory. We saw the operation of the Newmark helicopter autopilot, Decca Mk 8 and Flight Log and the lighting and angle-of-approach indicator layout beside the "beehive." The Sperry Zero Reader, Marconi AD.722 ADF and the VOR receiver which have been evaluated were not in use on this occasion.

Actual blind landings, using only Decca large-scale Flight Log charts, were achieved in a Sycamore some six years ago; and the BEA lighting pattern for night and poor-weather use, based on the Calvert principle, was described in *Flight* for April 11, 1958. Since then the BEA unit has done much of the development flying for the Newmark autopilot and the Sperry Zero Reader has been modified for use during helicopter approaches. Additional instrumentation is being developed including a speed-lock for the autopilot, a "barber's pole" vertical flight director for peripheral vision, and more advanced ground lighting. Principal unfulfilled requirements are a precise height indicator and a groundspeed indicator. A centimetric ILS is reported to be under development.

The ADF and VOR now work effectively, interference from rotor modulation having been overcome by modifications to the VOR receiver. The main aerial is beneath the fuselage; but because this leads to loss of signal in turns a gyro-operated switch selects a second aerial above the fuselage in such attitudes.

During the air-test flight last week, Capt Reid demonstrated the Newmark autopilot in its three operating modes. First he flew in the cruise setting, the autopilot taking attitude signals from the Sperry gyro vertical on the co-pilot's panel and attitude being adjusted by trim knobs on the main controller. Stabilization for pitch, roll and yaw axes was separately switched on. With a switch on the control column Capt Reid then selected the stabilize mode, in which rate-gyro signals provide short-term stabilization and pilot's control demands are superimposed from sensers at the base of the cyclic stick. The last mode is hover, in which gyro-magnetic compass heading signals maintain a selected heading during stabilized hovering. Collective pitch is manually controlled in all three modes. Complete circuits were made in the stabilize setting, and the equipment worked well in bumpy air.

The first approach was made visually on a 20° glide-slope defined by the two Calvert red/white VGPI lights located beside the cross of Lorraine pattern of high- and low-intensity lighting, the let-down being started from 1,200ft. The 20° slope looked more like 45° from the cockpit and very good downward visibility is necessary to keep the lights in sight. VGPI reference was lost at about 150ft, but by that time the transition was beginning. We next made a 15° approach on the lighting pattern, using Decca Mk 8 and a large-scale chart as the only reference. Chart markings showed the extended centreline and reference heights every 100ft, to which Capt Reid adhered expertly to arrive exactly over the pad.

Visibility minima established at present are 200ft and 400yd with Decca and 80ft and 150yd with ILS. The slender width of the pen-line on the Flight Log may represent an unacceptable error when a touch-down must be precise. Decca approach information could be presented on an ILS-type cross-pointer, but some complication would result if the approach were not substantially parallel to the lattice lines. It is intended that the instrument approach area round a heliport should extend over a circle of only one-mile radius to avoid interference between neighbouring sites.

One of the main problems in actually making these approaches lies in wind effect, both on groundspeed and on drift. When approach speeds are as low as 30kt drift may well be up to 40° and wind-shear and gradient greatly affect glide-slope performance. IAS is relatively unimportant, because the helicopter (unlike a fixed-wing aircraft) is in no danger of stalling, but groundspeed is all-important in maintaining descent angle. The lighting pattern must be embedded (and therefore fixed) in the landing area and the pattern can at best cover four approach directions, so cross-winds will inevitably occur. The transition from near-autorotative descent to hover, which is a difficult helicopter manœuvre even in visual flight, must be made accurately into the ground-cushion and over a limited ground distance. Some accurate height-reference is desirable, but both the radio and sonic altimeters now available are likely to become inaccurate over built-up or accidented ground. Doppler suffers similarly.

In the new turbine helicopters constant-speeding will greatly ease collective-pitch control and sufficient power will be available to hover safely at over 100ft, virtually out of ground-effect. In these circumstances a barometric altimeter may offer a sufficiently accurate height indication. Piloting may also be simpler if it is possible to separate cyclic and collective control to make the former govern speed and the latter descent gradient.

For helicopter use, the Zero Reader has been modified to accept additional signals from three rate-gyros and cyclic stick-position. An IAS term will be added to assist speed control. In present 20° ILS approaches the Zero Reader is set for the approach gradient and ILS signals. BEA propose to use an integrated director instrument display and a coupler for automatic approaches is being prepared. An automatic, programmed transition mode would be provided in the autopilot so that, at about 150ft, glide-slope control would be released and the transition made to hover under localizer control alone. Collective-pitch control would be automatic in this phase.

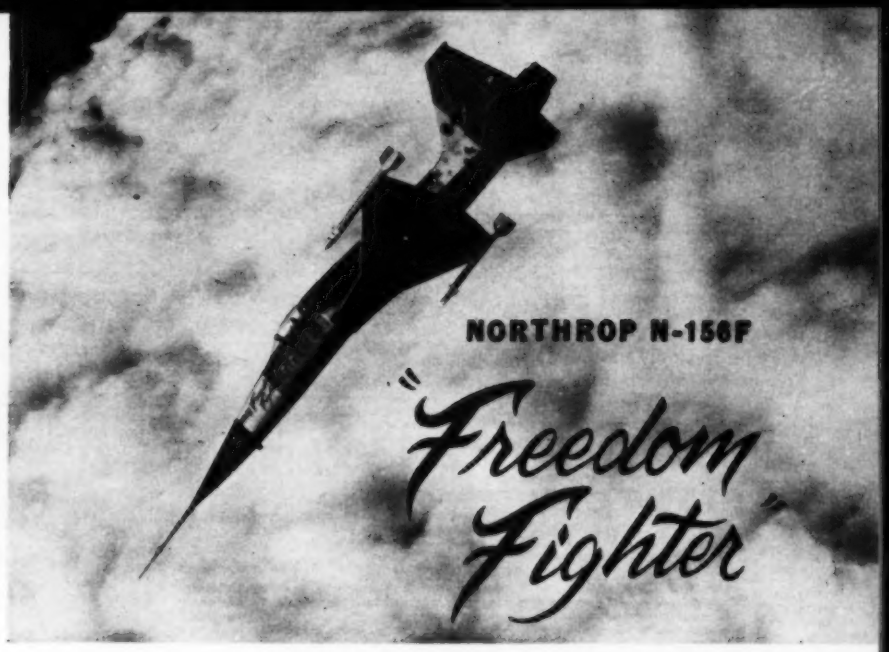
BEA have tried the Bendix sonic altimeter which transmits sound pulses at 3kc/s. Height indications are accurate to within 6in and maximum height is between 150ft and 300ft, but New York Airways have found public reaction to apparent machine-gunning created by the sound pulses to be slightly disconcerting.

The "barber's pole" instrument was produced by Smiths and is designed to provide rate-of-descent instructions from combined pitch-attitude and glide-slope signals to be visible in the pilot's peripheral field of vision. It consists of a black column about 1ft high painted with spiral white stripes and mounted to the left of the central instrument group. At a demand to increase rate of descent the column rotates at an appropriate speed, producing a distinctive downward motion of the stripe pattern. Strobed rows of lights might be used, and the system might be applied to the yaw axis, the instrument then being set horizontally.

Despite notable gaps in precise height and groundspeed indication, blind landing for helicopters in only relatively unobstructed sites seems to be a distinct possibility with existing equipment; and BEA have more practical experience of such operations than any other organization. The very elaborate Bell ANIP helicopter programme in America has not yet been conducted with such realistic requirements in mind—6° glide-slopes and unobstructed landing areas have been used. BEA is now training more pilots to the blind-landing technique.

The first operational application of this type of equipment has been planned by BEA for the Rotodyne, in which 550lb of weight has been set aside for control and navigation equipment. This will comprise duplicated stabilization and single autopilot, integrated director instruments, ILS, duplicated VHF radio, intercom and cabin address, navigation aids chosen from Decca, VOR or ADF and possibly a precision altimeter and some form of search radar. The last-named may be one of the new high-definition radars. It is realized that profitable Rotodyne operation must depend upon very high regularity.

Design and Development of America's First Military Assistance Programme Fighter



By ROBERT D. ARCHER, ARAeS

FOR many reasons, Northrop's N-156F multi-purpose fighter is an exceedingly interesting one. It is the result of an intensive study of modern American weapon systems, their cost versus effectiveness, and a growing realization that the price of these systems was fast putting them outside the reach of America's allies in Europe and Asia. The answer to this study can best be summed up in the phrase "Security with Solvency."

Northrop's studies of other weapon systems, particularly the Century-series fighters, showed that initial procurement costs were not the only major one to be contended with during their useful lifetime. The cost of establishing a new weapon system breaks down into three broad categories: research and development; procurement; and, finally, maintenance and operation. Analyses show that the last is the major cost in any operational system, and that it is proportional to design complexity.

Up to this period—with a few notable exceptions—improvements in aircraft performance were achieved by increasing size, cost and complexity. The N-156F broke this spiral by virtue of its decrease in size, made possible partly by a breakthrough in engine development. Early in 1955 Northrop's engineers became aware of a new family of small, high thrust/weight ratio turbojets under development by General Electric, primarily for missile applications. A very quick study resulted in a small supersonic fighter with two engines mounted in underwing pods and a slightly tapered straight wing. This became known as the "Tally-ho" fighter and created considerable management interest.

A closer look at the Tally-ho showed that it would be very difficult to obtain the desired performance, and a more detailed study resulted in the true ancestor of the present series. This project had the two engines mounted side-by-side in the rear fuselage, a low-mounted wing of low aspect-ratio and moderate sweep (25°) and a T-tail close-coupled to the wing. It is of some interest to appreciate why this configuration was chosen, and the answer is that it was designed as a naval fighter to operate off light carriers, of which the US Navy has a large number which could not handle the larger fighters then coming into service. These considerations led to the short fuselage and T-tail in order to obtain the minimum stowage volume.

The low wing was adopted so that it could be manufactured in one piece and permit the fuselage to retain four main longerons, thus simplifying the wing/fuselage attachment and saving weight. It also allowed the use of a wide-track inwards-retracting gear to confer good landing and taxying characteristics.

Prior to this study the Air Force had issued a general operational requirements for a supersonic basic trainer support system. In November 1955 Northrop management directed the preliminary design chief, W. E. Gasich, to initiate a specific design study to fulfil this requirement under the designation N-156T, in conjunction with the fighter airplane now labelled N-156F.

Further research, and experience of pitch-up with other Century-series fighters, had shown the desirability of increasing the horizontal-tail area, and mounting it low on the fuselage to fulfil stability and control requirements at supersonic speed. The same factors resulted in the novel addition of a large, retractable ventral fin, to be lowered at high speed from between the two engines mounted in the aft fuselage. Provision was also made for mounting a small rocket motor between the jet engines to provide extra thrust for high-speed combat. The fuselage nose was lengthened to obtain a better fineness ratio. All versions thus far had a wing area of 216 sq ft and 5° anhedral.

From this point on (March 1956) the trainer version took priority, as the Air Force ordered its development as the T-38 (now named Talon) to fill the GOR, a contract for 14 airframes being awarded in June.

The next definite trainer version retained the stepped tandem seating and general outline of the fuselage, but the surfaces were completely revised. The wing area was reduced to 170 sq ft because the naval carrier requirement no longer applied, and the plan-form was revised to give an aspect ratio of 4.75 with a quarter-chord sweep of 25°. Having a greater moment arm, the horizontal tail was reduced in area, and to replace the ventral fin the vertical tail was enlarged from 17 to 27 sq ft.

In an effort to reduce fuselage frontal area it was suggested that the nose should be drooped mechanically, in a similar fashion to that of the Fairey FD.2, in order to provide adequate view from the instructor's rear seat. This would have permitted a much lower canopy, but it was ruled out because it resulted in undue complexity and imposed a heavy weight penalty.

The next step resulted in extensive revisions to the fuselage lines in order to improve the performance. Maximum fuselage cross-section was reduced by moving the engines as close together as was practicable, the auxiliary rocket being discarded. The fuselage was bent in profile to provide the required vision, recontoured in plan to conform to the M1 area rule, and fillets were provided at the wing trailing edge.

Further refinement resulted in an increase in wing taper ratio, a reduction of sweepback of the vertical tail and re-fairing of the aft-fuselage lines to reduce basic drag. The most noticeable change, however, resulted in a marked characteristic of the N-156F design: the forward fuselage was cambered up to reduce both forebody drag and the pitch-up moment at zero lift. Colloquially known as the "lady slipper" fuselage, this resulted in the unique concave under-surface, and acts as a reminder of the long-forgotten research on cambered fuselages carried out by M. Woyevodsky which culminated in the Westland Dreadnought postal monoplane of 1923.

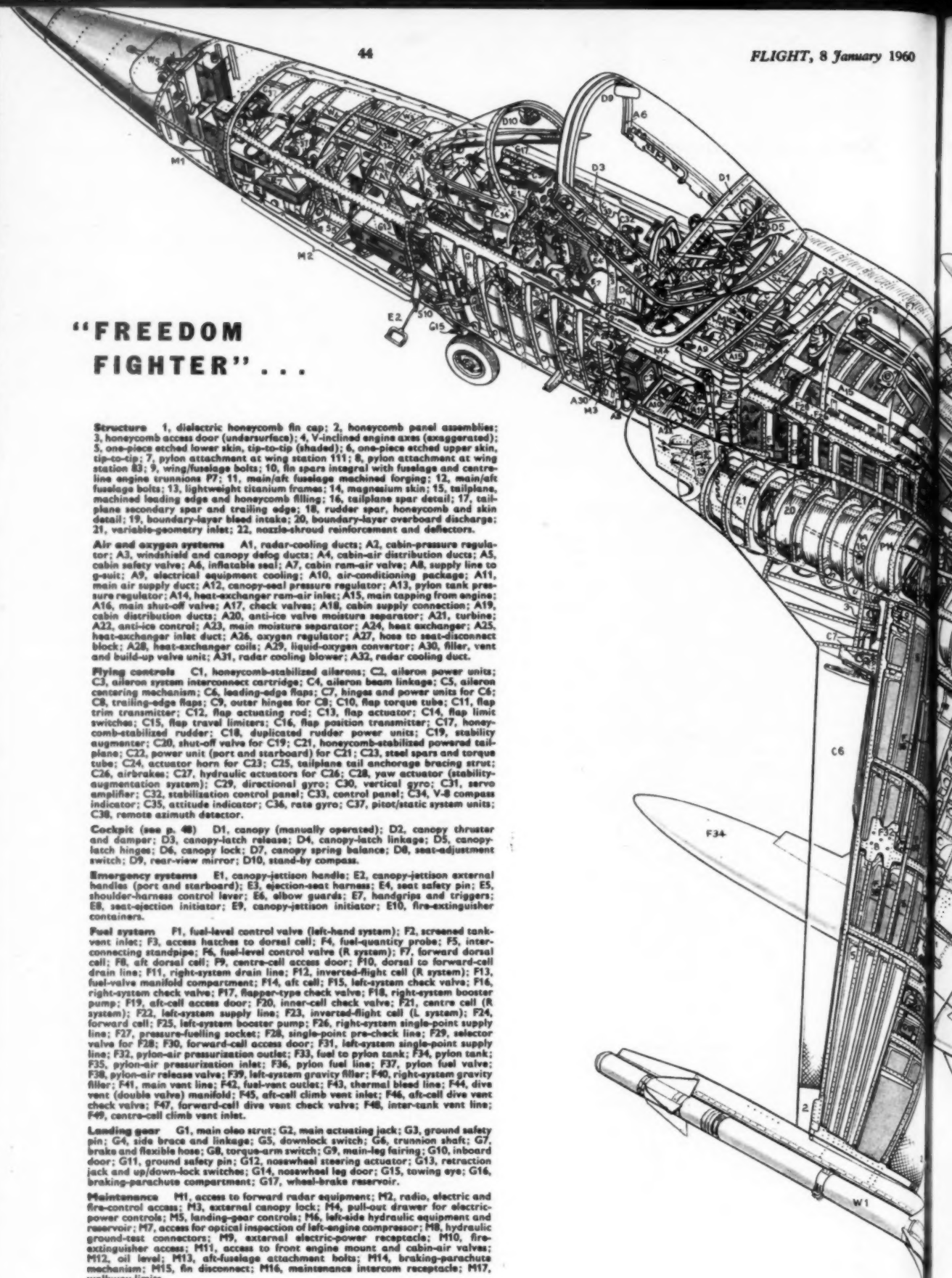
Revisions were made to the ailerons and engine installation. The intakes were moved forward 10in whilst the engines were moved 20in aft. The jet exits were brought 2in closer by slanting the engines apart at the compressor entry, this also improving the direct flow from the inlet duct. The fuselage/wing junction was reprofiled to M1.15, and the root fillets were deleted.

By this time the trainer had appeared in mock-up form and actual construction of the first airframe (serial 58-1191) was under way. Continued tunnel testing led to the conclusion that the swept vertical tail would not prove adequate under all conditions, and it was revised to the present form, its area being increased to 41 sq ft to compensate for the smaller moment arm.

Although the T-38 enjoyed priority through this period, the N-156F was not neglected, and constant effort to keep a common basic structure held major differences to the forward fuselage. However, an inherent basic divergence between the two aircraft arose as a result of their different performance requirements. The T-38 was designed to have maximum endurance on internal fuel, with resultant top speed in the region of M1.3. The N-156F

(Continued after double-page drawing of the N-156F)

"FREEDOM FIGHTER" . . .



Structure 1, dielectric honeycomb fin cap; 2, honeycomb panel assemblies; 3, honeycomb access door (undersurface); 4, V-inclined engine axes (exaggerated); 5, one-piece etched lower skin, tip-to-tip (shaded); 6, one-piece etched upper skin, tip-to-tip; 7, pylon attachment at wing station 111; 8, pylon attachment at wing station 83; 9, wing/fuselage bolts; 10, fin spars integral with fuselage and centre-line engine trunnions P7; 11, main/aft fuselage machined forging; 12, main/aft fuselage bolts; 13, lightweight titanium frames; 14, magnesium skin; 15, tailplane, machined leading edge and honeycomb filling; 16, tailplane spar detail; 17, tail-plane secondary spar and trailing edge; 18, rudder spar, honeycomb and skin detail; 19, boundary-layer bleed intake; 20, boundary-layer overboard discharge; 21, variable-geometry inlet; 22, nozzle-shroud reinforcement and deflectors.

Air and oxygen systems A1, radar-cooling ducts; A2, cabin-pressure regulator; A3, windshield and canopy defog ducts; A4, cabin-air distribution ducts; A5, cabin safety valve; A6, inflatable seal; A7, cabin ram-air valve; A8, supply line to g-suit; A9, electrical equipment cooling; A10, air-conditioning package; A11, main air supply duct; A12, canopy-seal pressure regulator; A13, pylon tank pressure regulator; A14, heat-exchanger ram-air inlet; A15, main tapping from engine; A16, main shut-off valve; A17, check valves; A18, cabin supply connection; A19, cabin distribution ducts; A20, anti-ice valve moisture separator; A21, turbine; A22, anti-ice control; A23, main moisture separator; A24, heat exchanger; A25, heat-exchanger inlet duct; A26, oxygen regulator; A27, hose to seat-disconnect block; A28, heat-exchanger coils; A29, liquid-oxygen convertor; A30, filler, vent and build-up valve unit; A31, radar cooling blower; A32, radar cooling duct.

Flying controls C1, honeycomb-stabilized ailerons; C2, aileron power units; C3, aileron system interconnect cartridge; C4, aileron beam linkage; C5, aileron centering mechanism; C6, leading-edge flaps; C7, hinges and power units for C6; C8, trailing-edge flaps; C9, outer hinges for C8; C10, flap torque tube; C11, flap trim transmitter; C12, flap actuating rod; C13, flap actuator; C14, flap limit switches; C15, flap travel limiters; C16, flap position transmitter; C17, honeycomb-stabilized rudder; C18, duplicated rudder power units; C19, stability augmenter; C20, shut-off valve for C19; C21, honeycomb-stabilized powered tail-plane; C22, power unit (port and starboard) for C21; C23, steel spars and torque tube; C24, actuator horn for C23; C25, tailplane tail anchorage bracing strut; C26, airbrakes; C27, hydraulic actuators for C26; C28, yaw actuator (stability-augmentation system); C29, directional gyro; C30, vertical gyro; C31, servo amplifier; C32, stabilization control panel; C33, control panel; C34, V-8 compass indicator; C35, attitude indicator; C36, rate gyro; C37, pitot/static system units; C38, remote azimuth detector.

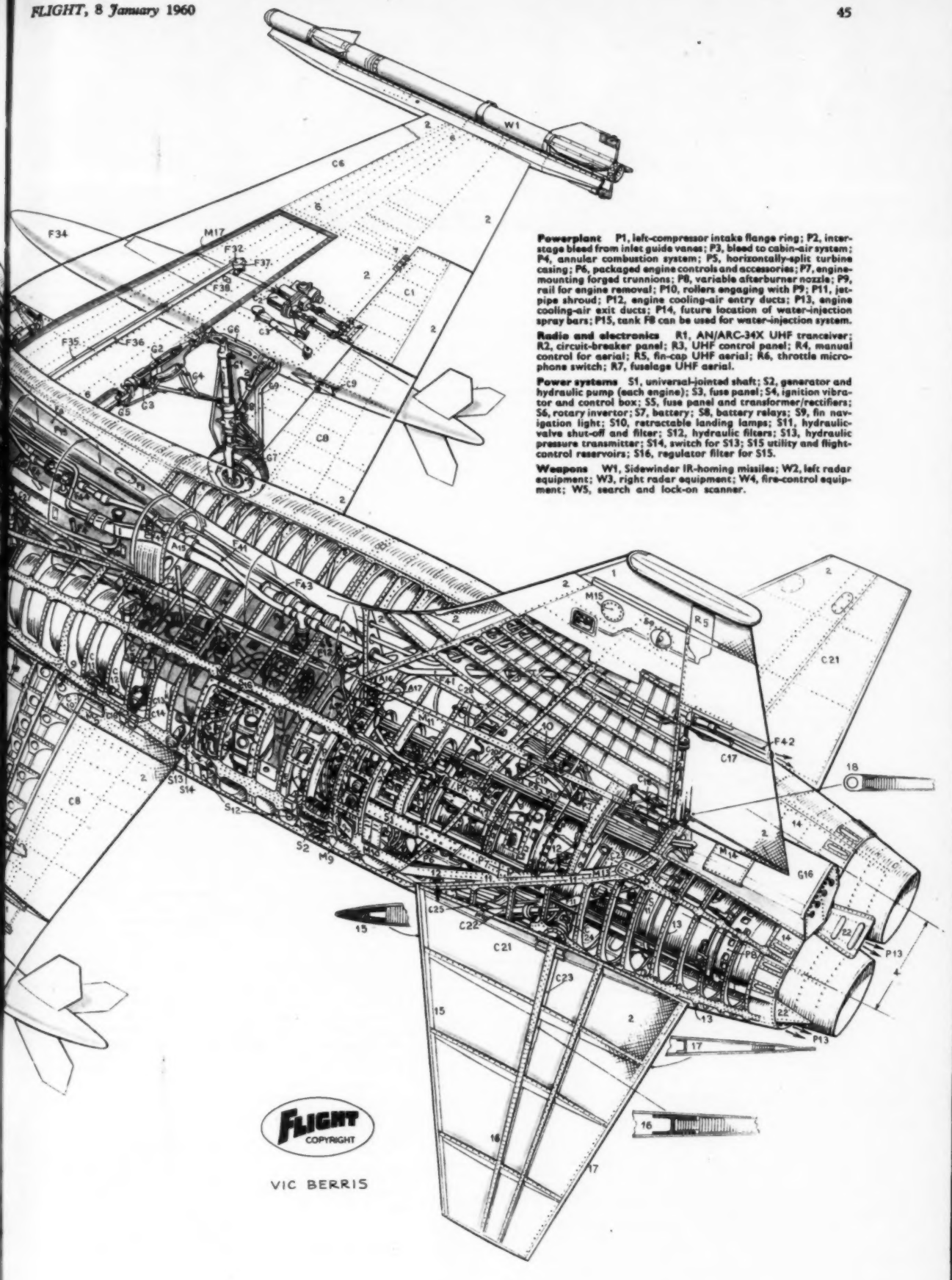
Cockpit (see p. 48) D1, canopy (manually operated); D2, canopy thruster and damper; D3, canopy-latch release; D4, canopy-latch linkage; D5, canopy-latch hinges; D6, canopy lock; D7, canopy spring balance; D8, seat-adjustment switch; D9, rear-view mirror; D10, stand-by compass.

Emergency systems E1, canopy-jettison handle; E2, canopy-jettison external handles (port and starboard); E3, ejection-seat harness; E4, seat safety pin; E5, shoulder-harness control lever; E6, elbow guards; E7, handgrips and triggers; E8, seat-ejection initiator; E9, canopy-jettison initiator; E10, fire-extinguisher containers.

Fuel system F1, fuel-level control valve (left-hand system); F2, screened tank-vent inlet; F3, access hatches to dorsal cell; F4, fuel-quantity probe; F5, inter-connecting standpipe; F6, fuel-level control valve (R system); F7, forward dorsal cell; F8, aft dorsal cell; F9, centre-cell access door; F10, dorsal to forward-cell drain line; F11, right-system drain line; F12, inverted-flight cell (R system); F13, fuel-valve manifold compartment; F14, aft cell; F15, left-system check valve; F16, right-system check valve; F17, flapper-type check valve; F18, right-system booster pump; F19, aft-cell access door; F20, inner-cell check valve; F21, centre cell (R system); F22, left-system supply line; F23, inverted-flight cell (L system); F24, forward cell; F25, left-system booster pump; F26, right-system single-point supply line; F27, pressure-fuelling socket; F28, single-point pre-check line; F29, selector valve for F28; F30, forward-cell access door; F31, left-system single-point supply line; F32, pylon-air pressurization outlet; F33, fuel to pylon tank; F34, pylon tank; F35, pylon-air pressurization inlet; F36, pylon fuel line; F37, pylon fuel valve; F38, pylon-air release valve; F39, left-system gravity filler; F40, right-system gravity filler; F41, main vent line; F42, fuel-vent outlet; F43, thermal bleed line; F44, dive vent (double valve) manifold; F45, aft-cell climb vent inlet; F46, aft-cell dive vent check valve; F47, forward-cell dive vent check valve; F48, inter-tank vent line; F49, centre-cell climb vent inlet.

Landing gear G1, main oleo strut; G2, main actuating jack; G3, ground safety pin; G4, side brace and linkage; G5, downlock switch; G6, trunnion shaft; G7, brake and flexible hose; G8, torque-arm switch; G9, main-leg fairing; G10, inboard door; G11, ground safety pin; G12, nosewheel steering actuator; G13, retraction jack and up/down-lock switches; G14, nosewheel leg door; G15, towing eye; G16, braking-parachute compartment; G17, wheel-brake reservoir.

Maintenance M1, access to forward radar equipment; M2, radio, electric and fire-control access; M3, external canopy lock; M4, pull-out drawer for electric-power controls; M5, landing-gear controls; M6, left-side hydraulic equipment and reservoir; M7, access for optical inspection of left-engine compressor; M8, hydraulic ground-test connectors; M9, external electric-power receptacle; M10, fire-extinguisher access; M11, access to front engine mount and cabin-air valves; M12, oil level; M13, aft-fuselage attachment bolts; M14, braking-parachute mechanism; M15, fin disconnect; M16, maintenance intercom receptacle; M17, walkway limits.

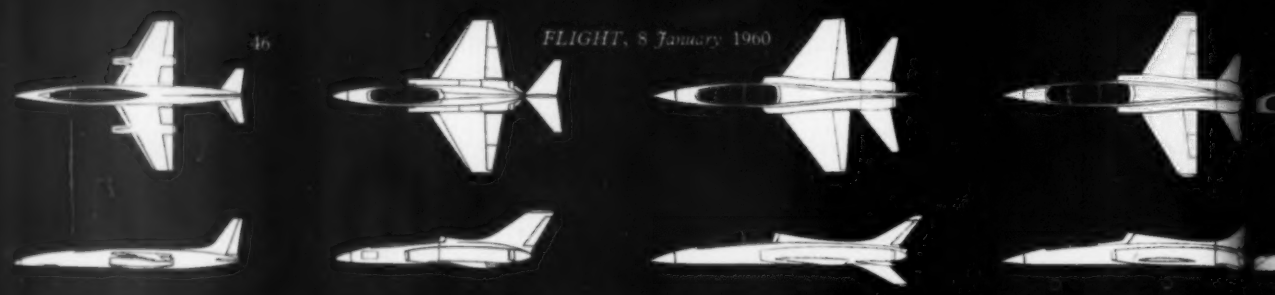


Powerplant P1, left-compressor intake flange ring; P2, interstage bleed from inlet guide vanes; P3, bleed to cabin-air system; P4, annular combustion system; P5, horizontally-split turbine casing; P6, packaged engine controls and accessories; P7, engine-mounting forged trunnions; P8, variable afterburner nozzle; P9, rail for engine removal; P10, rollers engaging with P9; P11, jet-pipe shroud; P12, engine cooling-air entry ducts; P13, engine cooling-air exit ducts; P14, future location of water-injection spray bars; P15, tank F8 can be used for water-injection system.

Radio and electronics R1, AN/ARC-34X UHF transceiver; R2, circuit-breaker panel; R3, UHF control panel; R4, manual control for aerial; R5, fin-cap UHF aerial; R6, throttle microphone switch; R7, fuselage UHF aerial.

Power systems S1, universal-jointed shaft; S2, generator and hydraulic pump (each engine); S3, fuse panel; S4, ignition vibrator and control box; S5, fuse panel and transformer/rectifiers; S6, rotary invertor; S7, battery; S8, battery relays; S9, fin navigation light; S10, retractable landing lamps; S11, hydraulic-valve shut-off and filter; S12, hydraulic filters; S13, hydraulic pressure transmitter; S14, switch for S13; S15 utility and flight-control reservoirs; S16, regulator filter for S15.

Weapons W1, Sidewinder IR-homing missiles; W2, left radar equipment; W3, right radar equipment; W4, fire-control equipment; W5, search and lock-on scanner.



Evolution of the N-156F: above are the N-156TX (March 1955), PD-2706 (November 1955), PD-2812 (January 1956) and PD-2832 (March 1956)

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was planned as an M1.5 machine, with a potential of greater than M2 when sufficient engine thrust could be provided.

The changes necessary on the fighter revolved around three main areas. The wing had an extension added at the inboard leading-edge root in order to decrease the local t/c ratio and increase the mean sweepback; this also decreased the wing wave drag. The engine intake ducts required a new inlet designed for maximum speed, and the M2 airplane will have variable intake geometry provided by an internal movable ramp. Another external change was the addition of leading-edge flaps, to increase the maximum lift coefficient to match the fighter's higher gross weight. Leading-edge flaps achieve this without the drag and pitch-up associated with other high-lift devices, and result in very small trim changes. In order to obtain the required short landing roll, a container was added above the rear fuselage to house a 15ft-diameter ring slot braking parachute.

In summary, it can be said that the N-156F design proceeded smoothly along a definite line of continual improvement, without some of the extreme overall changes suffered by many other aircraft during their gestation period. To a considerable extent this is due to the firm direction by Northrop's aerodynamic department, under G. C. Grogan. Credit must also be paid to General Electric's Small Aircraft Engine Department, who surpassed the performance promised many years previously.

With the T-38 Talon on the initial production lines, the Northrop management, under the direction of the late Whitley C. Collins, gave the engineering department the go-ahead on the N-156F on May 27, 1958, and set a date of May 31, 1959, for the roll-out. Project engineer Ray Gardner's team had many trials and tribulations in engineering the necessary changes; but close co-operation with the shops resulted in the target dates being met, and the roll-out was attended by representatives from over 40 "Allied" nations, at Norair's plant in Hawthorne, Cal. (The company had undergone a corporate reconstruction and became known as the Northrop Corporation, with the Norair division responsible for manned aircraft and missile production).

Prior to this, the aircraft became unique when the US Department of Defense allocated nearly $50m to Northrop and G.E. for engineering development of the airframe and engines. Norair's $32m covered three aircraft and a static-test airframe.

This unprecedented sponsorship of the N-156F is reflected in the first example's use of an Air Force serial number (59-4987) without any Air Force insignia and markings. Thomas V. Jones, president of Northrop Corporation, termed the aircraft a symbol of real partnership, and said that for the first time the Department of Defense had applied advanced technology directly to the military airpower problems existing abroad.

The fighter made its initial flight on July 30 last, going supersonic despite the low thrust available from the early non-afterburning YJ85-1 engines. Flight testing has proceeded smoothly, considerably assisted by experience with the first two YT-38 Talons. All flying has so far been at Edwards AFB, and throughout Norair's chief test pilot has been Lewis A. Nelson, whose views are given in the next eight paragraphs.

From the outset, the N-156F was designed with the pilot in mind. Throughout the design and development phases consideration of the pilot's inputs resulted in many of the outstanding features of the aircraft, such as the spacious cockpit with its outstanding visibility through the one-piece curved windshield. The most desirable control travel and forces were determined on a full-size flight control stand.

Among the facilities utilized in perfecting the flight behaviour were numerous tunnels, the full-size control test stand with simulator, actual system component parts, and the variable-stability F-86 aircraft of NASA. This F-86 was particularly valuable when early tunnel testing indicated a possible lateral directional-control deficiency with the existing vertical tail design. Actual flight experience with it confirmed these predictions, and led to the present vertical tail with increased area and reduced sweep.

Flight testing has advanced very rapidly, as borne out by the fact that a "three-card" test (of flight-test requirements) was conducted on the initial flight, and that the aircraft was flown for preliminary evaluation by a US Air Force project pilot on its third flight. These facts attest to the excellence of the engineering effort in the design stages and to the thoroughness of pre-flight planning. They are all the more impressive when one considers that all flying to date has been conducted with modified prototype YJ85-1 "missile" engines. These were utilized in lieu of production J85-5s in order to start flying at the earliest possible date. As they produce only about half the thrust of the reheat engines, all flying has, in effect, simulated the one-engine-out case. Notwithstanding this, 94987 has flown carrying some 1,200lb of test instrumentation (quite often with one engine out).

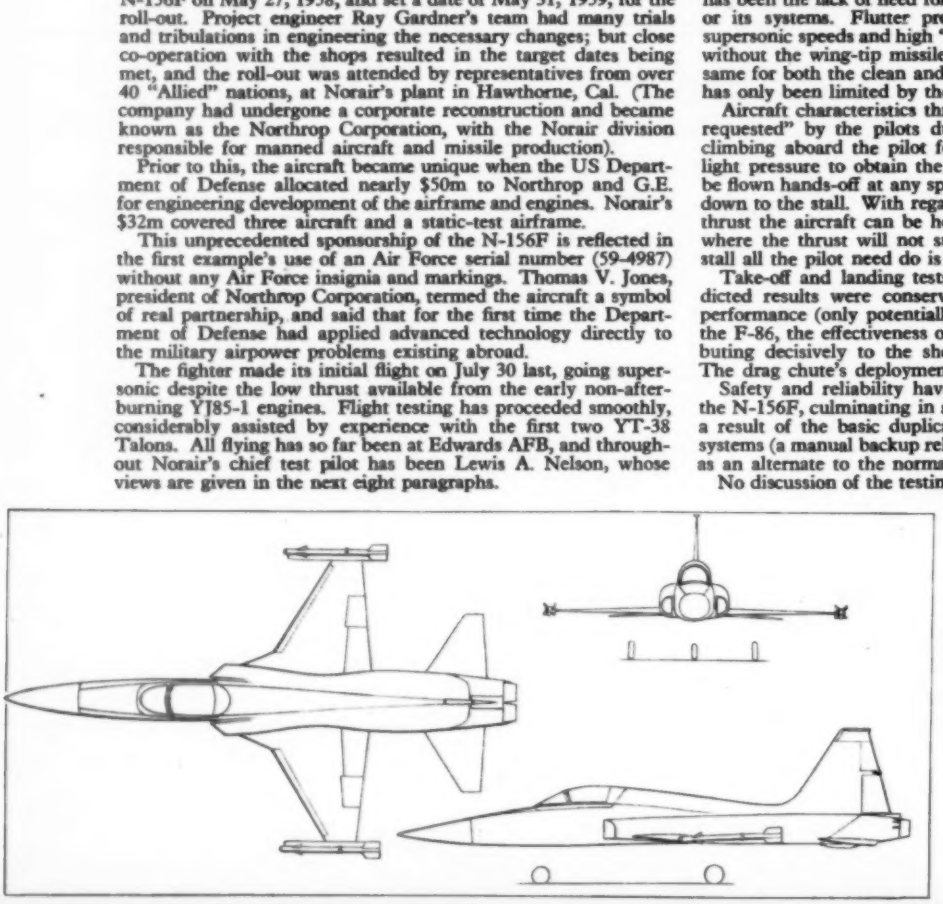
A prime reason for the rapid progress of the test programme has been the lack of need for any major alteration to the airframe or its systems. Flutter proof-testing has advanced rapidly to supersonic speeds and high "q" dynamic pressures, both with and without the wing-tip missiles. Proof-test maximum speed is the same for both the clean and missile-installed configurations, and has only been limited by the low thrust so far available.

Aircraft characteristics throughout the flight envelope are "as requested" by the pilots during the design phase. From first climbing aboard the pilot feels at home, and needs only apply light pressure to obtain the desired response. The aircraft can be flown hands-off at any speed—supersonic, transonic and right down to the stall. With regard to the stall: with the present low thrust the aircraft can be held completely controlled at a point where the thrust will not sustain it, and in order to break the stall all the pilot need do is lower the nose and fly out.

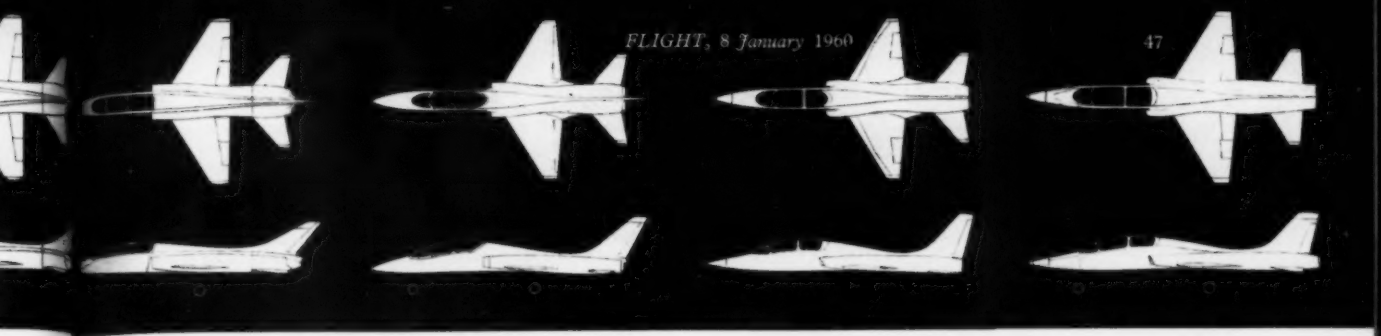
Take-off and landing tests indicate conclusively that the predicted results were conservative. The N-156F combines M2 performance (only potentially as yet) with the landing speed of the F-86, the effectiveness of the wheel brakes and drag contributing decisively to the short roll necessary in forward-areas. The drag chute's deployment rate and stability are outstanding.

Safety and reliability have been key words in the design of the N-156F, culminating in a reduction in emergency systems as a result of the basic duplication of powerplants and accessory systems (a manual backup release is provided for the landing gear as an alternate to the normal utility hydraulic system).

No discussion of the testing of the N-156F would be complete



This drawing depicts the final N-156F design. The following data apply: engines, two GE J85-5; span, 25ft 3in; length, 45ft 1in; height, 13ft 1in; tailplane span, 15ft 4in; wheelbase, 11ft 2in; track, 10ft 9in; gross weight, 12,190lb (overload limit with external stores, 16,300lb); max speed, in excess of M2 (1,320 m.p.h.); range, more than 2,000 miles with external tanks; landing distance from 50ft, approximately 3,000ft



On this page are the PD-2852 droop-nose (March 1956), and the PD-2879A, 2879B and 2879D, the last-named being dated December 1956

without mention of the effectiveness of the USAF category concept of testing. This is worthy of an article on its own, but, briefly, it is a joint effort between Northrop, as the system contractor, and the Air Force, acting for the Department of Defense.

Structure

The structure of the N-156F has been broken down into small units to facilitate a high degree of flexibility in manufacture and ease of replacement in case of damage. It has also been so designed that spares for both the fighter and trainer can be built on a common line, some 80 per cent of the components aft of the forward fuselage being interchangeable.

Dealing with the wing first, this is a single unit from tip to tip, of multi-spar construction in aluminium alloy. The main torque box is supplemented by a secondary torque box, whose rear wall is formed by the rear spar which supports the single slotted flaps and the inboard ailerons.

The ailerons are of the sealed-gap type, having a piano-wire type hinge on the top surface. They are fully powered without trim tabs, and when the landing gear is retracted have a movement of 18½° up and 14° down. Each leading-edge flap is of aluminium-alloy honey-comb construction, with a continuous hinge and a travel of 23° down. The wing tips, also honeycomb-filled, are readily detachable, being either plain or incorporating the missile pylon. Provision has been made for pylon attachments at wing stations 83 and 111 (see diagram on page 48).

After the wing structure has been assembled, complete with the necessary wiring and piping, the main landing gear with strut doors is attached, rigged and checked out for functioning. The wing is then ready for assembling to the fuselage. This ensures that the wing is manufactured as a complete entity and allows of dispersed manufacture—so that, for example, wings made in one country could be fitted to fuselages manufactured in another. The checking out of the gear retraction cycle at this stage also simplifies trouble-shooting, to the extent that, if the wing functions correctly detached and does not when assembled to the fuselage, then the fault can be sought in the latter. The wing/fuselage joint involves only one bolt from each of the three spars to the bottom fuselage longeron on either side, all fore and aft.

The forward fuselage contains the fire-control and electronic equipment, nose gear, communications and navigation equipment, and the cockpit, ejection seat and controls. The fire-control space has a volume of some 40 cu ft and has been designed to accommodate a variety of systems to suit customers' requirements. The upper longerons serve as the cockpit rails and also support the canopy, which is of singular interest. The forward windshield is a one-piece curved panel providing an unobscured view forward; it is hinged at its forward end to provide easy access to the rear of the instrument panel. The one-piece canopy is novel in being raised and lowered manually by a lever on the right-hand inside wall of the cockpit, thus saving weight and maintenance time over the hydraulic system normally employed. External jettisoning is provided on both sides of the aircraft.

The mid-section of the fuselage is the largest single subassembly, and contains the wing attachments, fuel tanks, air ducts, forward compartments and vertical fin. The basic construction consists of four longerons, bulkheads and a floor for the tank compartment. The unusual construction of the vertical fin integral with the main fuselage was chosen so that maintenance on the engines could be performed by removing only the easily-handled aft-fuselage and tailplane.

Forward, the aft fuselage is of stiff construction to take the loads from the tailplane through the canted fuselage joint; aft, it is composed of very light titanium frames covered externally with magnesium skin. Drag-parachute loads are taken forward and down to the main structure, the compartment being of magnesium.

The empennage of the N-156F consists of the fin and rudder and the all-movable tailplane. The latter has a single spar attached to a steel torque tube, and the entire chord serves as the torque box, being of honeycomb construction. Its limits of travel are 17° nose down and 8° nose up. The vertical fin uses a single canted spar, attached to the main engine bulkhead, and has integrally stiffened skins. The rudder is hinged to the fin's shear web, and is of honeycomb construction. With landing gear down it has a maximum movement of ±30°, but to avoid large fin loads during yaw normal travel is reduced to ±6°.

Conventional air/oil shock-struts are used in the landing gear. The nose unit retracts forward and the wide-track main gear inward, the wheels being housed above the flat undersurface of the fuselage. The main-gear retraction system deserves special mention owing to its clever utilization of the basic wing geometry. Designed and developed by the Cleveland Pneumatic Tool Co, the entire system including the main leg folds up into a depth marginally over 3.25in. This was made possible by retracting the main leg sideways at 90° to the fore-and-aft axis, to lie behind the rear spar which is inclined forward at its inboard end. the side brace, of the on-centre link type, is attached at its lower end to the forward side of the main leg by a universal coupling. Its upper end is held by a rotating pivot on the rear spar, running outboard from which is a U-beam rotating in lugs on the spar web. A hydraulic actuator inside (and rotating with) the U-beam, breaks the side brace upwards via another on-centre linkage. In so doing, the side brace is rotated upwards and folds back on itself to lie between the main leg and the spar.

Originally of built-up steel construction, the one-piece outer cylinder and drag-brace forging is now of high-strength aluminium. Each shock strut carries a wheel with inboard brake and 20×6.0 tubeless tyre. The independent braking system has its own reservoir, and is of the single manual pressure-generating type (rather than using the now usual power assistance).

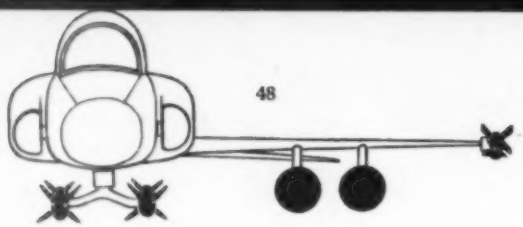
The nose gear uses an 18×4.4 tubeless tyre, and has a combined shimmy damper and steering unit, which traverses through ±50°. Both the nose and main units have a manual release system, which allows them to fall free and lock down following failure of the utility hydraulic system.

The 15ft Irving drag parachute is stowed in a compartment so positioned that the deployment bag does not hit the ground—thus shortening its effective life. When deployed, the chute's drag passes through the mean c.g., thus avoiding undesirable pitching moments. The deployment and jettison system is manually operated, and does not rely on springs. It has been designed to last the expected life span of the aircraft, without attention.

Powerplant

The heart of any aircraft is its powerplant; and this is especially true of the N-156F, designed around the General Electric J85-5 (*Flight*, December 11). Development of this type of engine was sparked by Rolls-Royce's development of the Soar turbojet, with an unprecedented thrust/weight ratio. General Electric began developing the J85 for missile applications in 1955, and when Northrop's interest became apparent it was modified for aircraft use, producing 2,500lb dry and 3,850lb with afterburner. The latest announced development is the addition of water injection

Every effort has been made to provide optimum access to equipment



Sparrow 2 (2)	Sparrow 3	Sidewinder	Sidewinder
Falcon (2)	Falcon	Bullpup	Falcon
Sidewinder (2)	0.50in gun pack (4)	Zuni pack (4)	2.75in FFAR (12)
Bullpup	T-171 "Gatling"	2.75in FFAR (12)	2in FFAR (24)
Zuni pack (2 x 4=8)	20mm pack	2.75in FFAR (24)	
2.75in FFAR (24)	Bombs, 500 lb	2in FFAR (24)	
0.50in gun pack (2)	Bombs, 1,000 lb	0.50in gun pack (2)	
0.50in gun pack (4)	Napalm, 750 lb	7.62mm gun pack	
T-171 "Gatling" 20mm pack	Recon. pod	Bombs, 500 lb	
Bombs, 500 lb (2)	150 U.S. gal tank	Bombs, 750 lb	
Bombs, 1,000 lb (2)	200 U.S. gal tank	Napalm, 750 lb	
Bombs, 2,000 lb			
Napalm, 750 lb			
Recon. pod			
200 U.S. gal tank			

External stores can be carried on the centreline, and at wing stations 83, 111 and tips. This illustration shows possible loads at each location

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forward of the compressor entry, which provides sufficient extra thrust to boost the N-156F's top speed to well over M2.

Weight of the J85-5 is but 525lb; it is 21in in diameter and 104in long over the afterburner. This makes its removal and installation very simple, with a built-in overhead track and simple two-point mounting in the mid-fuselage. Contributing to the ease of installation is the accessory package, containing the hydraulic pump and electric generator. This is mounted on the airframe and driven through a universally mounted shaft.

The engine bay is cooled from a series of static bleed ports just forward of the compressor entry, while the engine itself is cooled by air bled from the main intake ducts. Originally it was intended that for ground running that air would be sucked forwards from the exit holes in the last frame. However, it was found to be much more efficient to have uni-directional flow, and ejector nozzles were added to the tail end of the aircraft to effect this. As a result, production airframes will differ in detail from the three aircraft already built in regard to location of the drag-chute compartment. A cartridge starter is fitted to the right-hand engine; bleed air is then used to start the other. Both can be started or motored by low-pressure air from a ground source.

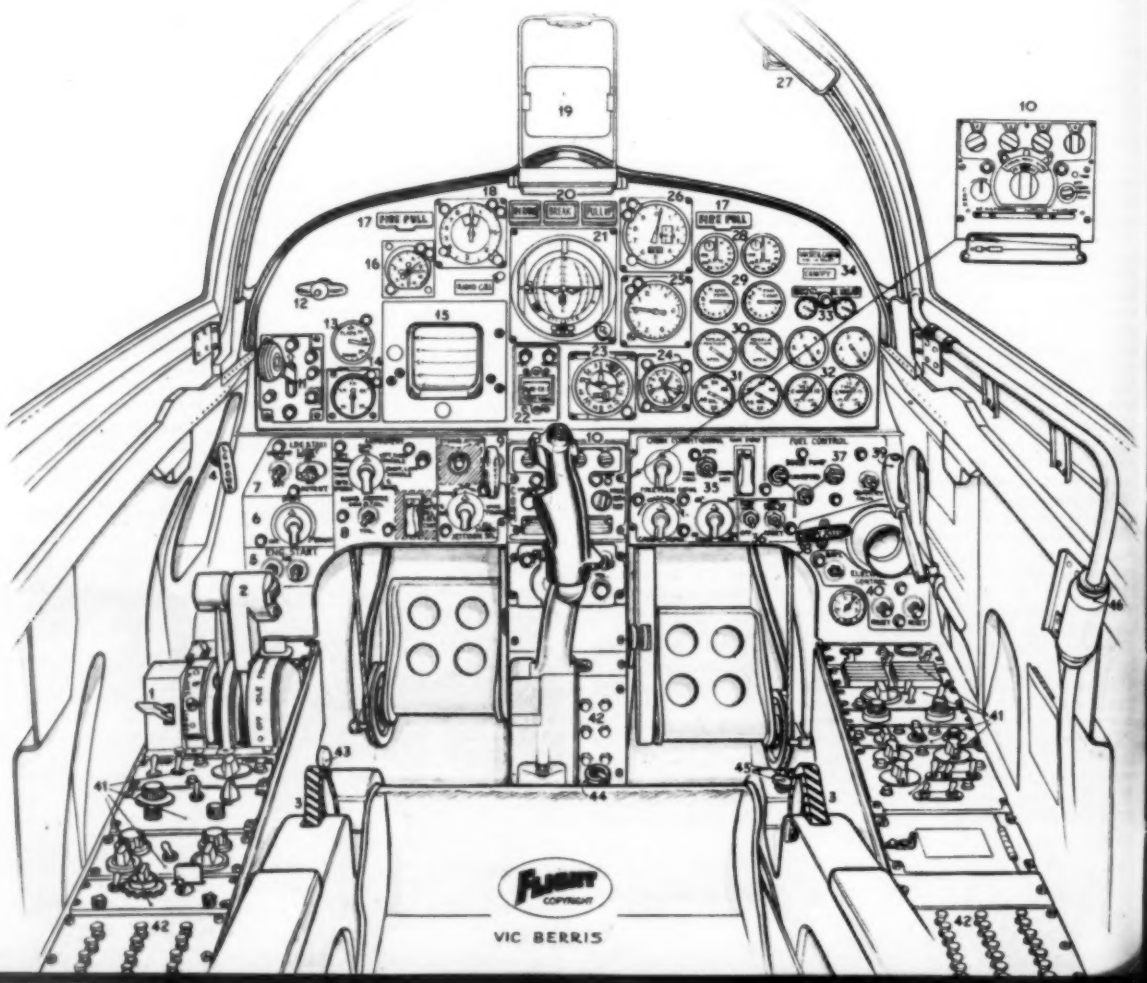
As alternative powerplants, the Pratt & Whitney J60 (JT-12) and Rolls-Royce RB.153 have been considered in detail, and can be made available upon customer request.

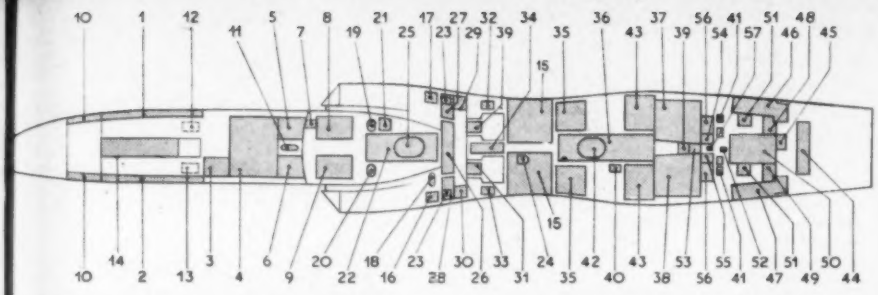
Systems

Fuel System: There are separate circuits for each engine, interconnected by a cross-feed valve. No fuel is carried in the wing, the left-hand circuit being served by two dorsal cells and a forward cell, while the right-hand is fed from a centre and aft cell. Both forward and aft cells incorporate an inverted-flight cell, to supply the engines in all flight attitudes. Single-point refuelling permits pressure-fuelling of all tanks simultaneously, with provision for manual filling of each cell when necessary. Total capacity is approximately 600 US (500 Imp) gal, all cells being of bladder-type construction. Each tank has an AC-driven booster pump, but gravity feed is possible in emergency.

Electrical System: This is of the three-phase, 320-480c/s 115/200V AC type, driving the booster pumps, fuel valves, trimming devices, flaps, air-conditioning and pressurization equipment. The two AC generators are of the 8kVA 6,300-9,600 r.p.m. air-cooled, self-excited type; each is driven from a separate gearbox provided at the forward face of each engine, so that full electrical

1, Flap lever; 2, paired throttle levers, airbrake switch and press-to-transmit button; 3, ejection-seat arming lever containing firing trigger (both sides); 4, undercarriage emergency down; 5, engine starting; 6, gunsight dimmer; 7, external lights; 8, armament selector switches; 9, stores jettison; 10, UHF radio; 11, landing gear; 12, drag-chute release; 13, flap indicator; 14, cabin altimeter; 15, radar scope, elevation and azimuth; 16, g-meter; 17, fire extinguishers (both sides); 18, ASI/Machmeter; 19, aiming sight; 20, "in range," "break" and "pull up" warnings; 21, master attitude indicator (director needles, compass heading, slip and turn); 22, radar range meter; 23, RMI and range counter; 24, clock; 25, VSI; 26, altimeter; 27, mirror (standby compass behind); 28, r.p.m.; 29, j.p.t.; 30, jetpipe-nozzle position; 31, oil pressure; 32, fuel quantity; 33, utility and flight-control hydraulic pressure; 34, master attention-getter and canopy unlocked warning lights; 35, cabin conditioning and pressure-suit demist controls; 36, pitot heating and engine anti-icing; 37, fuel transfer and cross-feed; 38, canopy jettison; 39, canopy-operating; 40, electrical system; 41, oxygen, autostabilizer, radio and other panels on side consoles; 42, circuit-breakers; 43, harness unlocking; 44, oxygen supply; 45, ejection-seat safety catch (height-adjustment switch beyond); 46, canopy demisting, breaks here when canopy opens (canopy is depicted in closed position).





This diagram gives an indication of the profusion of access panels on the underside of the fuselage

1, 2, Radio, electrical and fire control (left and right); 3, controls, stations 194/208; 4, controls, stations 208/235; 5, 6, controls, stations 235/253 (l, r); 7, oxygen convertor filler; 8, 9, lower equipment stations 253/277 (l, r); 10, forward radar (l, r); 11, pylon electrical connecter; 12, 13, equipment bay, station 185/194 (l, r); 14, nosewheel door; 15, mainwheel door (l, r); 16, 17, hydraulic check valve (l, r); 18, inboard hydraulics, stations 318/325; 19, fuel selector valve; 20, fuel drain valve; 21, fuelling coupling; 22, controls tunnel, stations 284/325; 23, wing attach points (l, r); 24, fuel probe (four more mounted dorsally); 25, forward tank; 26-34, speedbrake panels; 35, flap actuators and wing attach bolts (l, r); 36, control tunnel, stations 390/445; 37, 38, gearbox (l, r); 39, throttle quadrant; 40, fuel drain; 41, engine oil fill and drain; 42, aft fuel tank; 43, aft wing attach bolt (l, r); 44, hydraulic equipment; 45, tailplane torque tube; 46, 47, tailplane and hydraulic equipment (l, r); 48-50, flying controls (l, r and centre); 51, air for starting engines (l, r); 52, controls, station 482; 53, controls, stations 464/471; 54, 55, engine speed adjustment (l, r); 56, controls, stations 471/478 (l, r); 57, controls, station 475.

power remains after failure of either powerplant. An external ground power receptacle is provided. Two 25-amp transformer/rectifiers supply 28V DC power to charge the nickel-cadmium battery, which energizes a single-phase 115V 400c/s inverter supplying ignition during engine starts.

Hydraulic System: There are two completely independent power systems, the flight-control system and utility hydraulic system. Each is of the pressurized closed-centre 3,000lb/sq in type, with a pressurized reservoir. The flight-control system is powered by a pump driven by the right-hand engine while the utility system is supplied by the left-hand engine, both being in operation at all times. Under normal operation each system supplies half the force needed for control-surface movement, following failure of one system, the other is capable of controlling the aircraft in normal flight, the transfer being automatic without pilot action or crossover power, each circuit having independent distribution. The utility system, in addition to providing half the power for the flight controls, serves the landing gear and its doors, speedbrakes, stability augmenters and nosewheel steering.

Full power controls are provided for the aircraft's ailerons, tailplane and rudder. The ailerons each have a dual hydraulic actuator, controlled by a cable system from the control stick. The rudder pedals are connected by cables and push-rods to servo valves on dual actuators. In order to avoid large vertical-tail loads during yaw manœuvres, pedal travel is restricted when the landing gear is retracted. A subsystem provides Dutch-roll damping, and interconnection between the rudder and ailerons compensates for non-linear inertia forces during roll manœuvres, and provides rudder trim authority.

Spring and a bob-weight provide the stick forces and centering action for the tailplane, which is powered by two tandem hydraulic actuators. One cylinder of each actuator is powered by the flight-control hydraulic system, the other by the utility. Controls from the stick to the servo valves are duplicated, and pitch damping is provided. Freeplay is eliminated by preloading the actuators through the torque tube.

Automatic trim-change takes place when the flaps are lowered or raised, and a push-button control allows the pilot to select the correct tailplane angle for take-off with hands off the stick. Trim is provided for all three surfaces, operation of switches on the stick grip controlling the tailplane and ailerons, while a potentiometer on the left-hand console trims the rudder. Movement of the trailing-edge flaps also actuates the leading-edge flaps, both systems being electrically driven. The speed brakes are located under the centre fuselage, and can be depressed to any angle up to 46°. Each is actuated by its own hydraulic jack, but both are controlled by a single switch on the r-h. power lever.

Northrop pioneered fully powered controls from the B-35 onwards (British Messier manufacture full power servos under Northrop licence). A new feature incorporated in the N-156F's system is the use of a Teflon high-pressure cup-type seal, backed up by a low-pressure O-ring with a return leakage drain between the two. These seals have proved effective at up to 350° F, and to have a life of over 5,000,000 cycles.

The first N-156F is here seen at Edwards, with two YT-38 Talons

Provided in the navigation and communication system are UHF, Tacan, IFF, range radar, infra-red search equipment and a bomb director system for use with the LABS technique. The pilot is seated in a rocket powered, zero-altitude ejection seat of Norair design. It is capable of ejecting through the canopy if necessary, and a single pin safeties it on the ground. The seat has been sled-proven at up to M1 at Hurricane Mesa.

Particular emphasis has been placed throughout the design on ease of maintenance. To collect data on actual field experience, Norair sent teams of engineers out to bases operating Century-series aircraft. Based on the wealth of data thus gained, studies were made of the degree of skill necessary to service the N-156F anywhere in the world, taking a conservative level as representative. These studies show that maintenance manhours per flight are only 21.5, compared to two Century figures of over 40.

It is worthy of note that there are 111 access panels on the fuselage alone, comprising some 25 per cent of the surface area (see illustration above). All operational fittings and connections are readily reached. Components liable to frequent replacement are located in the most accessible positions and all others can be tested *in situ* (e.g., the boost-pump pressure output can be checked through a convenient port on the fuel-valve manifold). Very little ground support equipment is required to service the aircraft because virtually all systems are located at waist or chest-height. Perhaps the best evidence of the fighter's small demands is that even in the testing phase Northrop's ground staff consists only of a crew chief and four mechanics.

A high degree of safety is designed into the N-156F, based on studies of other operational fighters. As the two engines energize two independent electrical systems, failure of one merely reduces available performance. USAF accident statistics show that twin-engined fighters suffer approximately one-quarter the attrition rates of single-engined types. Moreover, the handling characteristics of the fighter during take-off and landing are markedly superior to those of competitive aircraft.

No ram-air turbine is needed in the event of complete powerplant failure; the windmilling engines supply sufficient hydraulic and electric power to maintain control down to and including the landing. The aircraft can also be landed on one aileron.

From its inception the N-156F has been regarded as an advanced armament-launching platform to provide versatility in its role as a counter-air fighter (counter-air is the USAF definition for the destruction of enemy airpower both in the air and on the ground). So, although the basic armament consists of two Sidewinder IR air-to-air missiles mounted at the wing tips, the aircraft has the capacity to utilize at least 48 different combinations of external stores (see sketch, page 48).

In keeping with the overall concept, Northrop's human engineering personnel have developed a new type of non-compensating optical sight called Norsight. It is of minimum weight and bulk, and can thus be mounted close to the pilot without obstructing the primary panel. While dispensing with the customary expensive electronic computer, it provides for delivery of all the weapons that the fighter can carry.

The design of the N-156F was based on three main operational concepts: that operational and maintenance facilities are fewer and less complete in NATO and SEATO than in the USA; that there was a shortage of skilled technical personnel, but a good supply of non-rated or low-skilled personnel; and that the aircraft would be built under licence in NATO and SEATO countries. It thus represents Northrop's solution to these varied requirements, while minimizing the unit price in order to attract the largest number of customers, but without sacrificing performance or operational effectiveness.

Two main missions are envisaged. The first presupposes the use of fixed bases with a reasonable level of engineering support, while

"Freedom Fighter" . . .

the second deploys the aircraft at dispersed advanced bases with fixed pit-type launchers or portable zero-length launchers. Additionally, the 156F can be operated from very short fields by using four 1,000lb JATO bottles for take-off and a "Liquid-Squeezer" arresting system; the latter cuts landing roll to only 1,000ft, and can accept up to four aircraft per minute. Use of these techniques allows of the maximum dispersion of the aircraft, and brings to mind the methods used so successfully by the Luftwaffe in the closing months of World War 2. These make almost any straight stretch of highway into an airfield, capable of being quickly adapted to suit varying situations. Such dispersed fields are difficult to put out of action, especially by unmanned missiles.

Emphasis on low initial and recurring costs has resulted in marked economy compared to other contemporary types, reflected in the number of aircraft that can be supported on a given budget. A study was made of the anticipated funds that the NATO and SEAT countries would spend in support of the fighter mission between 1959 and 1965. It was assumed that two competitive aircraft types would be supplied under the military assistance programme, this freeing the budget for operational costs only. It was found that the same amount of funds would be sufficient to procure and support 38 per cent more N-156Fs than one type and 46 per cent more than the other.

After making 32 flights with the original YJ85-1 engines the first airframe has been refitted with YJ85-5s. The second and third aircraft are due to fly this month and in March, respectively, and the third is fully representative of production aircraft in that it has full weapon-system capability.

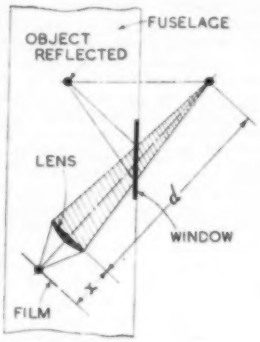
Now that the North American F-108 has been cancelled, the reader may be excused for thinking that the N-156F bids fair to be the last manned fighter to be designed in the USA. However, the Northrop Corporation is confident that it represents only the first of a new family of manned combat aircraft.

Correspondence

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns. Names and addresses of writers, not for publication in detail, must in all cases accompany letters.

Mystery Picture

REGARDING the letter from H. G. Cloete-Noding and his puzzle picture (December 25 issue): just in case he has not discovered it for himself already, the following should answer his questions.



Referring to the diagram, focus is achieved by adjusting distance x in relation to distance d. The window merely bends the shaded triangle, the length of which remains the same. Your correspondent's picture could be a view forward and to starboard, showing the reflection of the gentleman in the front seat, or looking aft with reflection of someone else in the back seat, port side. The dark area in the corner could be, respectively, the lower edge of the window frame or the wing trailing-edge.

I will not reflect further on this subject, but just wish everyone a happy New Year. *Flight* through the letter box on the first day! A good start.

St Albans, Herts — JOHN P. BUTTERS

Airline Safety

I THINK that there must be a misprint in your article "Airline Flight Safety," in the issue of December 25. You report Capt Miles as saying, "Detailing the area of flight in which the greatest danger could occur, the speaker mentioned the landing phase and the increasing number of overshoots. This came from the pilots' concern with overshooting on marginal-length runways." Surely the word "overshoots" is a misprint for "undershoots"? [Not literally a misprint, but a transcription error—Ed.]

If the above assumption is correct, Capt Miles is certainly in very good company in singling out the undershoot problem as an area of flight safety which at the present time needs the most urgent reappraisal. In the United States, the United Kingdom and at ICAO we know that studies are afoot, but is the degree of urgency fully recognized? In the UK some refinements have been added to the landing requirements for jet aircraft, but much still remains to be done, especially in the wet-runway case. On an international basis, we are still using essentially the same formula for the measurement of landing distance of jets as was used for the DC-3. But look at the new factors which have crept in:—

(1) From the outer marker to the threshold a typical modern jet must dissipate 32kt, calling for a deceleration of about 14kt/min; corresponding figures for the DC-3 are 15kt at 5kt/min. Clearly the jet pilot has a much greater problem in arriving at the threshold at the correct speed. This will introduce a greater scatter of landing distances, thereby increasing the tendency to overshoot and to undershoot.

(2) The modern jet transport is a much heavier aeroplane, and approaches faster, than the DC-3. Thus, during the flare-out, considerably high centripetal forces are induced. These temporarily put up the wing loading and the stalling speed, bringing the aeroplane nearer to the "mush" point—which tendency is typical of the class of undershoot and heavy landing now occurring.

(3) The clean design of the jet gives rise to a longer float than the piston-engined aeroplane; so if it arrives at the threshold a little fast, the pilot cannot get it down so early on its wheels and is slower to initiate effective braking. The result is a much greater penalty in landing distances than the same error would produce in older aircraft.

(4) The very great contribution of reverse thrust on the piston-engined aeroplanes is, if it exists at all on the jet, very substantially reduced.

(5) During an approach the application of power to the propeller-driven aeroplane provides, by reason of slipstream effect, an almost instantaneous increase (about 10kt) in the margin above stall. Conversely, the reduction of power immediately introduces a large propeller drag. These two effects together give the pilot a close control of speed. On the jet, however, an increase in power will not increase the margin above stall until the aeroplane's speed has had time to build up; and the reduction of power will introduce no braking effect.

The above factors will combine to a greater or lesser extent on all jet landings and, as a result, the new jet pilot will find an almost inexplicable scatter in his landing distances—some of them (due to factors 1, 3, 4, and 5) tending to take him closer to the upwind end of the runway than is comfortable. To control this he will subsequently endeavour to cut back his speed and height on the approach. But with this technique factor 5 can still be adverse; and with any speed reduction factor 2 raises its ugly head, occasionally perhaps devouring the whole of the safety margin. These effects can, of course, be minimized by very thorough training, but they cannot be altogether eliminated. The result is a net increase in undershoots and heavy landings.

London W1 — C. C. JACKSON,
Executive Secretary,
International Federation of Air Line Pilots Associations

"Flite" Readers' Corner

DEAR pp. 909 thru 954.—Your informational product *Flite* (25/12/59/789-793) initiated our Christmas festivization at 0948 hr GMT X-day minus wun. Ace newshound EBN's outstanding uncovering of interesting picstories pp. 789, 790 and 792 earns gratitudinal approbation of all who believe in importance of publicization of cultural superiority of the Free World.—Cordially,

London W1 — 771/3/8

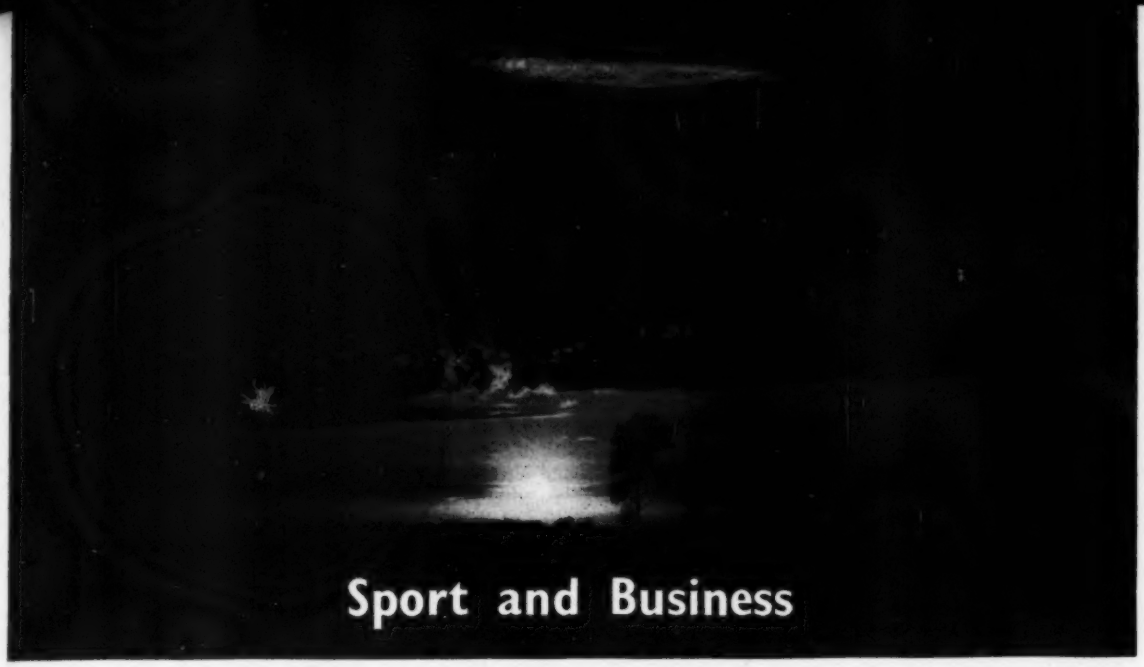
I AM most anxious to join the staff of *Flite* and would like to point out that I have special qualifications for Windmill assignments, having made a special study of helicopters. Please reserve for me the symposium delegate on the left (page 792) as my private secretary.

Birmingham 14 — MAURICE AUSTIN

FORTHCOMING EVENTS

Jan. 8. Helicopter Association: "The Development and Flight Testing of Helicopters," by G. J. Sarsted and A. V. Coles.
Jan. 9. British Interplanetary Society: Film Show.
Jan. 12. Photogrammetric Society: "Small Scale Mapping," by Messrs. Wild Heerbrugg of Switzerland.
Jan. 12. RAeS: 94th Anniversary Lunch.
Jan. 13. Kronfeld Club: "National Aerobatic Contest," by Flt Lt B. B. Sharman.
Jan. 14. RAeS Astronautics and Guided Flight Section: "Future of Automatic Control on Fixed-wing Aircraft," by Prof G. A. Whitfield.
Jan. 15. Denham Flying Club: First Annual Dinner.
Jan. 15. RAeS (Agricultural Aviation Group): "Biological Factors in Agricultural Aviation," by C. V. Dadd.
Jan. 15. Institute of Navigation: "Heading Definition in Commercial Aircraft," by J. Green and A. P. Glenny.
Jan. 16. British Interplanetary Society: Schools Lecture, "The Scientific Exploration of Space," by Dr N. H. Langton.
Jan. 19. RAeS: "Some Aerodynamic Problems of Engine Installation," by Dr J. Seddon.
Jan. 20. Kronfeld Club: "Some experiences of Flying from 1914 Onwards," by R. M. Charley.

RAeS Branch Fixtures (to Jan. 15): Jan. 13, Chester, "Parachutes and Parachute Design," by S. B. Jackson. Jan. 15, Preston, Annual Dinner and Dance.



Sport and Business

This outstanding picture of a Slingsby Skylark 2 at sunset was taken at Lasham by Harry Hensser and was reproduced on the British Gliding Association's Christmas card for 1959. The photograph is one of a collection shortly to be published, together with a commentary on gliding by Philip Wills, in a new Max Parrish book "The Beauty of Gliding"

THE UNITED STATES TEAM for the 1960 World Gliding Championships, to be held at Butzweilerhof, near Cologne, during June 4-19, will include Richard Johnson and Richard Schreder, with Paul Schweizer as team captain. Johnson was automatically assured of first place on the seeded list by becoming the 1959 US national champion. The number of pilots per country has not yet been divulged by the organizers of the championships, the German Aero Club, but is generally assumed to be not less than two and not more than four. Third and fourth on the US seeded list are Paul Bikle and Lyle Maxey.

Delay in announcing the British team for the championships is also presumably due to the uncertainty concerning the maximum permitted number of pilots. The top six British pilots, named in alphabetical order by the British Gliding Association last August, are Anthony Deane-Drummond, Anthony Goodhart, Nicholas Goodhart, David Ince, Geoffrey Stephenson and John Williamson. Since then, however, Stephenson has reaffirmed his decision to retire from world contest gliding and so must be considered ineligible. For the first time since the first international gliding championships (in Germany in 1937) the British team this year will not include Philip Wills—at least, not as a competing pilot.

THE NUMBER OF DIFFERENT TYPES of aircraft sold by W. S. Shackleton Ltd, the London firm of aviation brokers, has now reached 150. The last ten types were Tri-Pacer, Desford, Drover, Apache, Twin Bonanza, Cessna 172, Piaggio P.166, Prentice, Linnet, Ambassador and Douglas DC-2. The 150th type, the DC-2, was sold for a South African operator to a customer in France. Among current types offered by the company is the executive version of the North American F-51D Mustang built by Trans-Florida Aviation Inc, a photograph of which appears below.

FIRST ANNUAL DINNER of Denham Flying Club will be held on Friday, January 15 at the Piccadilly Hotel, London. At Denham Aerodrome the Link training centre under David Pearce has been extremely busy since its opening some two months ago.

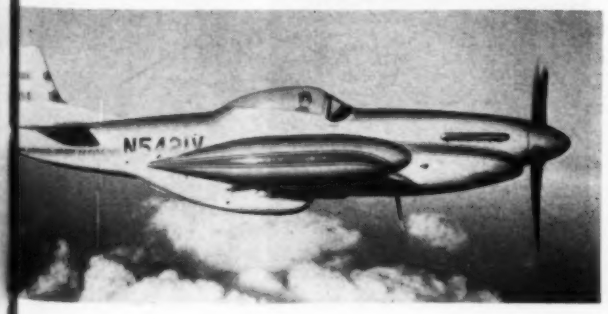
WELL KNOWN TO PRE-WAR PRIVATE PILOTS as aviation manager of National Benzole, and pilot of the firm's Puss Moth and Leopard Moth aircraft, J. J. Scholes retired from the company on December 31. A founder member of Lancashire Aero Club, he was appointed manager of the Lancashire division of National Benzole in 1948, when the company decided not to re-enter the aviation fuel market after the war. He had been aviation manager from 1930 to 1939.

A GLIDING SECTION is being formed by Norfolk and Norwich Aero Club, whose flying base is Swanton Morley Airfield. A two-seat Kranich and an Olympia have been purchased from a Swedish gliding club.

AN UPRATED VERSION of the Potez 4.E light-aircraft engine is now being bench-tested and will shortly be flown in a Jodel Ambassadeur. Designated 4.E-02, it gives 105 h.p. instead of 90 h.p., but weighs no more and still fits the same mounting. Three examples have so far been built.

LIST PRICES of the seven executive aircraft types offered by Beech Aircraft Corporation for 1960, announced at the company's annual sales meeting recently, are: Beechcraft Super G18 (seven-seat), $126,000; Model 65 Queen Air (six-seat), $120,000; H50 Twin-Bonanza (six- or seven-seat), $95,500; D50C Twin-Bonanza, $83,000; B95 Travel Air (four- or five-seat), $51,500; M35 Bonanza (four-seat), $25,300 and Model 33 Debonair (four-seat), $19,995.

Details of Trans-Florida Aviation's executive version of the F-51D Mustang are now available in this country from W. S. Shackleton Ltd. The executive Mustang carries two people at a normal cruising speed of 360 m.p.h. (max. continuous cruise 424 m.p.h.). Duty-paid price in the UK, including comprehensive rodio, is £14,500



"Wet Wot" is the alliterative appellation of this experimental seaplane version of the Currie Wot built by Hampshire Aeroplane Club at Eastleigh Airport, Southampton. Taxying trials were made towards the end of last year, since when the aircraft has reverted to wheels. The Mikron-powered Wot was described in our issue of December 4

Straight and Level

THERE was a time when a man of science propounded his theories or argued his causes before some learned society. Today we see a revolutionary principle of aeronautical engineering—the Barnes Wallis Swallow—broken upon the world by a process of security leaks, rumour and refutation, coy suggestion, blurted dogma and, at length, by a full exposition before an audience of schoolboys. Not only was this juvenile assembly the first to receive an authentic account of the Wallis polymorph principle (which may well bring about something of a revolution in world aviation, and in the fortunes of the British aircraft industry)—it was also the chosen instrument for the breaking of a security ban on a new type of naval aircraft.

There is something gravely disturbing here, suggestive of puerility and discord in places where wise counsels and singleness of purpose should prevail.

Perhaps our new Minister of Aviation will look very deeply into this inept affair—and disperse the ineptitude before it can mar an achievement of great brilliance.

● As the best throw-away line of 1959 I rate the last sentence on page 714 of *Flight* for December 11. It concluded a report by a Sikorsky engineer following a visit to Russia—a report which we suggested "constitutes one of the most interesting documents to date on the subject of Russian aviation."

The throw-away read as follows:—

"Mr. Yakovlev and Andrei Tupolev both indicated that they are presently building a Mach 2 transport."

● No air force could have had a more persuasive propagandist than the RAF's retiring Chief of the Air Staff. Sir Dermot Boyle could have sold the new missile-armed RAF to the most die-hard supporters of manned aircraft. At the same time he was just as persuasive in telling university cadets that there would be a future for them as regular aircrew.

When he appeared in that successful TV film, *This Is Your Royal Air Force*, no parent could have doubted that the RAF was the right Service for a son to join. And when the Queen attended the 40th anniversary dinner of the RAF, she could not have had a more personable host. Sir Dermot's career—pre-war instructing duties and success as an aerobatic pilot, wartime command of a bomber squadron and subsequent staff posts, then four years at the head of affairs and now retirement at the age of 55—epitomizes the youthfulness of the Service he has loved so well.

● Emphasizing the admittedly high cost of new jet aircraft, the new Parliamentary Secretary to the Ministry of Aviation, Mr Rippon, said in the Commons: "In this as in other fields we have to pioneer or perish."

I asked Sir Charles Boost, firebrand champion of British supremacy in the air, for his comments on these fine, resounding words. "Magnificent, old boy, absolutely magnificent," he said. "I shall have them translated into Latin and nailed onto the Boost coat of arms as the new family motto. Pioneer or perish—splendid! If we pioneer *and* perish it won't have been because we made the wrong approach to air transport."

● Amazing, isn't it, how the emotion of prestige can supervene where considerations of national security have hitherto prevailed? In theory at least the performance of the American century-series fighters is secret. But, with the Russians establishing new world records in rather monotonous succession, the Americans are falling over themselves to set new speed and altitude marks—and to proclaim them to the world.

At least we are getting some good sport out of these manned fighters before they are thrown on the scrap heap.

● A friend who recently visited British East Africa, and whose passport describes him as a "Citizen of the United Kingdom and Colonies," had to do some form-filling before entering the British Colony of Kenya.

On an Entry Declaration Form (Kenya Immigration Regulations, 1957) he not only had to duplicate information already supplied for his Visitor's Pass. In addition he had to declare his race ("in the case of non-Europeans include father's and grandfather's names, or, if a married woman, include the names of husband and husband's father"). And he had to say whether he had "ever been convicted in any country of crime punishable by imprisonment."

The air service on which he travelled was a British Colonial coach flight, which can only carry to Kenya traffic originating in the United Kingdom. And when he travelled into Uganda, he had to fill in more forms and produce his passport.

All over the world thousands of people in airlines and travel agencies are spending thousands of pounds promoting the delights of tourism and air travel. Meanwhile thousands of others are devising more and more frustrating forms to make tourism and air travel as irksome as possible. Some of us wish that they would call the whole thing off.

Footnote: A *Flight* colleague who recently visited the USSR had to fill in one simple, uninquisitive form only.

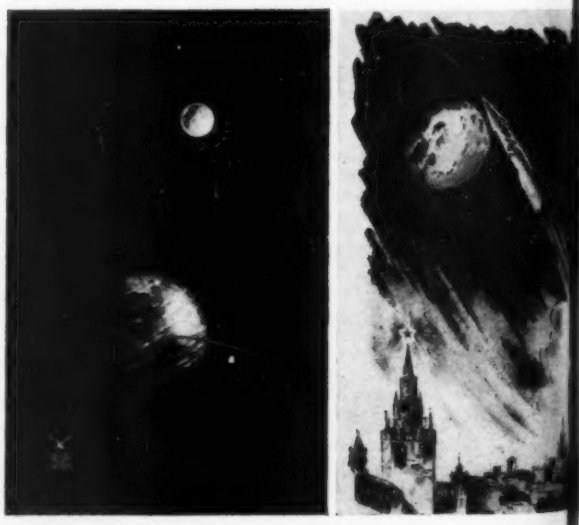
● *Big jet take-off performance, Quotation Number One*:

"A decision has been made to lengthen [London Airport's] runway number five by 1,500ft . . . there should be no more noise than at present, say the officials, as the rate of climb of the aircraft from the extension [*sic*] should be about the same as before." [*Middlesex Chronicle*]

Big jet take-off performance, Quotation Number Two:

"Brussels National Airport will be ready to receive the first Boeing 707-320 towards the end of this year . . . A runway of 2,175 miles is under construction . . ." [*Sabena Interline News*]

ROGER BACON



Two national minds with but a single thought — Moon rockets for Christmas. Interestingly enough these cards came to "Flight" from the Pentagon (left) and the Soviet Embassy in London. Notice the differences? One is neat, well designed, tasteful; the other somewhat crude and rough. Respective moon shot scores to date: one neat tasteful rocket past the Moon; three crude rough rockets past, on to and around the Moon (with pictures)

Off shortly for an extensive Avro 748 sales tour of the Far East is Prince Emanuel Golitzine (right), sales manager of A. V. Roe. Now promoting the Avro 748 in Africa are Michael Cooper-Slipper, A. V. Roe sales, and Kenneth Edgerton, chief performance engineer

AIR COMMERCE

NEW ORDER FOR COMETS

AFTER more than two years of negotiation, the long-expected order from Misrair for de Havilland Comets has finally been placed. It was announced in Cairo on December 30 that the UAR airline had signed a contract for three Comet 4Cs for delivery from this summer. With spares and equipment the value of the order is £4m and it brings the total of firm orders for Comets to 42; other contracts are said to be "in an advanced stage of negotiation."

De Havilland say that before deciding on the Comet, Misrair made a thorough technical evaluation of practically every jet and propeller-turbine aircraft available now or in the near future, and that the contract was concluded in the face of strong foreign competition, both technical and financial. Of the protracted delay in placing the order, which has now been expected for many months, the manufacturers state that this was due "entirely to monetary exchange difficulties between the two countries. During the two years of negotiation it has been significant that at no time have political difficulties influenced the amicable discussion between the airline and de Havilland." The Comets will be used on Misrair Viscount routes and on resumed Egyptian services to London.

Significant also is an agreement between Misrair and Aerolineas Argentinas signed shortly before the Comet order; the two airlines are to establish a route connecting South America and the Middle East. This will be a joint Comet operation with Aerolineas passengers at Rome transferring to Misrair Comets for destinations in the Middle East. Dr Ricardo Monfarrell, vice-president of Aerolineas Argentinas, said recently that within a year his airline's Comets would be operating into Cairo. In doing so they will be providing additional competition for BOAC, who hope (see "*South American Rentrée*," page 37) to use their South American service as a traffic generator for the Near and Far Eastern routes.

C.U.T. FARES WITH EAGLE

LAST week Eagle announced, in conjunction with the Commonwealth Union of Trade (formed on January 6, 1959, "for closer contact between peoples of the Commonwealth"), air travel plans which bear a striking similarity to Eagle's very-low-fare applications of December 1958.

The services proposed are to be operated fortnightly—an East African service to Nairobi *via* Malta, and a Far East service to Hong Kong *via* Nicosia and Singapore. The aircraft to be used are DC-6Cs. Fares correspond exactly with those filed in Eagle's VLF applications—see table on page 59.

Technically, in the eyes of IATA (and the Ministry), the Commonwealth Union of Trade is a "closed group." Membership fee is £3 10s per year and only members are able to take advantage of the proposed services. So far as schedules are concerned "departure dates do not form a regular pattern." However, a timetable is published: on the first and sixteenth of each month, starting on February 1 until April 16, services to Singapore and Hong Kong will be operated. Similarly, the East African services to Nairobi *via* Malta will start on January 28 and will be operated "approximately fortnightly" until April 26. After these dates, presumably, a new timetable will be issued.

The combination of the "closed group" and the "irregular pattern" of the new services is intended to distinguish them from scheduled services, which would not be permitted by law. The Act reads as follows: "[A scheduled service] is one of a series of journeys which are undertaken between the same two places and which together amount to a systematic service operated in such a manner that the benefits thereof are available to members of the public from time to time seeking to take advantage of it."

Initiative for the new proposals is said to have come from C.U.T.; the services will comply with the Act in being neither "systematic" nor *directly* "available to . . . the public."

This VLF development is likely to have wide repercussions. For the moment BOAC and BEA, both of whom could be adversely affected, are making no comment. Obviously Eagle have good reasons for apparently "jumping the VLF gun" at a time when the whole future of independents is delicately in the balance, with mergers rumoured almost every day of the week.

Meanwhile, any member of the public who wants to fly, say, to Nairobi and back for £101 should apply for membership of C.U.T., care of Eagle Aviation, 40 Edgware Road, London W2.

Footnote: The Commonwealth Union of Trade has as its president Sir Evelyn Wrench, CMG, LLD. The chairman is Bertie Joel.

BOEING 720s FOR LUFTHANSA

ANNOUNCED in Cologne on December 23 was Deustche Lufthansa's decision to buy from Boeing three 720B-030s, the Pratt and Whitney JT3D turbofan-powered version of the medium-range airliner in the Boeing transport family. No statement has been made about the price that Lufthansa expect to pay, but it is said that delivery in 1961 is expected. The aircraft are to be used on services to the Middle and Far East and to

Continued overleaf

COLLISION AVOIDANCE COMPULSION?

THE problem of collision avoidance is not so much one of how to make a suitable system as of how best to put it to use. Collision avoidance has certain problems in common with an automatic dishwasher. From advertisements an automatic dishwasher seems a very good idea; only after buying one do you find that the plumbing has to be altered, that there are difficulties with the electrical wiring, and that you still have to load it in a special way and scrape the plates first. Installing collision avoidance is going to be something like the dishwasher problem; particularly when space on the flight deck and the best locations for antennae are at a premium.

All we can be sure of is that collision avoidance is needed, because: (1) it removes the hazard of mid-air collision from which there is no chance of saving life and (2) it can safely reduce the "grain size" of an aircraft from the thousands of cubic miles presently used in Atlantic ATC separations to less than 1,000 cu miles. The first is a human benefit, the second an economic one.

The need is for an avoidance system and not merely a warning one, because at closing speeds of say, Mach 6, a warning is of little use to the human pilot. The device has to detect, think and act within the normal reaction time of a human being; but it will also be very necessary to prevent the system falling into disrepute because too great a proportion of the avoiding actions are found to be unnecessary. How to check whether the system has been unnecessarily cautious is yet another problem to be solved.

There are many different ways of detecting the presence of another aircraft, and each has its advantages and disadvantages. The basic problem is essentially one of making the best use of the available information and of making the chosen system compatible with other safety and navigation devices. This leads to the most awkward of all the problems: national and international standardization. Unless there is early agreement the whole business will be a half-hearted affair, confused by the respective claims of rival systems.

Many of the technical problems can be overcome if, instead of a self-contained avoidance system being fitted to each aircraft, there is some measure of co-operation between individual aircraft systems. With radar techniques, for example, each aircraft should have, in addition to its own detection set, a transponder to provide easily processed information to all other aircraft flying within range.

For the probability of a mid-air collision to be minimized, international agreement must be advanced to a degree of efficiency which will ensure positive and precise aircraft control in specific air spaces. Areas might be defined in which no aircraft might fly unless equipped with a prescribed collision avoidance device. This is not as radical as it sounds; such descrimination already exists as, for example, in the Amber One Decca Airway.

A recent decision of the Federal Aviation Agency in the US with respect to storm radar (see "You Must Have Radar," *Flight*, August 28, 1959, page 93) is an example of the legislation which some authorities do not hesitate to use if the safety of aviation warrants it; the same could well apply to collision avoidance systems.

L.F.E.C.

Undergoing a major overhaul by American Airlines after 2,130 hours' service with their fleet is the Boeing 707 flagship. Excluding work done in the accessory and supporting shops, 1,344 operations were carried out in just under 13,100 man-hours—about 12 per cent more than forecast

AIR COMMERCE . . .

South America. The logic of the decision seems particularly clear on the last-named route; fastest of all the Boeing series, and with an extended range conferred by its turbofans, the 720 also has the best airfield performance combined with a more moderate capacity than Lufthansa's 707-420s which, for the time being, may be too large for the already thinly spread traffic over the South Atlantic; 1961 may see Lufthansa's 720s operating services for the three Air Union carriers on the route.

AIR TRAFFIC IN 1959

PROVISIONAL figures issued at the end of 1959 by ICAO reveal, as expected, that air transport recovered from the recession of 1958. Arithmetic applied to ICAO's figures, assuming that a passenger mile is a 200lb/mile, suggests that total scheduled international load ton-miles carried in 1959 were about 12 per cent up on those in 1958. It will be recalled that the 1958 rate of growth over 1957 was only 5 per cent (1 per cent in America and 12 per cent elsewhere in the world).

Of the 96 million passengers carried in 1959—10 per cent more than last year's 87 million—about 95 million were carried by IATA, according to a provisional estimate of that association.

ICAO's figures show that cargo ton-miles in 1959, 1,295 million, are 14 per cent up and mail ton-miles, 355 million, are 11 per cent up. Passenger-miles are 12 per cent up. Comparative rates of increase in 1958 over the previous year were, respectively, 2 per cent cargo, 9 per cent mail, 5 per cent passengers.

An interesting trend in the pattern is that the total number of hours flown, for the first time in ICAO's post-war history, dropped —by 1 per cent, reflecting the higher speed of the new jet transports.

Meanwhile IATA estimate that passenger traffic may well rise from the 95 million in 1959 to possibly 103 million in 1960—an increase which, if mail and freight do well too, suggests a rate of increase for air traffic in 1960 of about the same order as that achieved in 1959. IATA reckon also that North Atlantic passengers should reach two million in 1960 "by all present indications." It will have taken only two years from the point in 1958 where the moving annual total on this route first exceeded one million.

RIO CLOSED TO JETS

THE collision between a VASP Viscount and a Brazilian Air Force T.6 over Rio de Janeiro Airport on December 22, in which 42 people lost their lives, occurred while a BOAC Comet on a South American proving flight was starting its practice let-down to Rio de Janeiro's Galeao Airport. Disconcerting as this news was to the passengers in the Comet (among them a *Flight* representative) the accident serves to focus attention on the unhappy circumstances of Rio's airports.

It may be many months after the start of BOAC's new service before Comets can fly to Rio, one of the scheduled stops in Brazil on the South Atlantic run. In August tarmac patches which had been laid over the concrete runways were lifted, according to the airport authorities, by Aerolineas Argentinas' Comets; combined with plans to extend the runway to 10,800ft the poor condition of the surface made immediate repairs necessary. While they are in progress only 5,250ft are available, sufficient for some piston engined airliners but inadequate for Aerolineas Argentinas or BOAC Comets.

Calling a meeting of all the carriers using the airport, the Brazilian authorities proposed four different plans. If all operators and the Brazilian Air Force were prepared to move to Santa Cruz Airport—about two hours' drive from the capital—repair and lengthening of the runway could be completed by April 15. This plan was favoured by BOAC, Aerolineas Argentinas, PanAm, Varig (who have recently started Caravelle operations) and Transcontinental. The second suggestion was that Galeao should remain open to piston-engined traffic but exclude jets until at least June 15. The third and fourth proposals involved different arrangements with the Brazilian Air Force.

Not unnaturally, Panair do Brasil strongly resisted any suggestion that they should move from Galeao to Santa Cruz, as all their base maintenance is done at Galeao and to move out "would mean a virtual suspension of operations." Also, Panair should receive their first DC-8s in June, but as these will probably not now arrive until October it has been widely suggested by competitive carriers who may have to leave Galeao that if they go the impetus to complete the extensions before the big jets arrived might be lost.

Seen installed on a PanAm 707 at Renton, Washington, is the ground jet-noise suppressor manufactured by the Industrial Acoustics Company of New York. Unlike most other types of ground suppressor, it is mounted directly to the engine

By Christmas a final decision had not been reached, but it seems probable that Galeao will be closed to jets and to BOAC's new service for some months at least. On one of the three South American proving flights the Comet night-stopped at Santa Cruz, where staff to handle it had gained access only an hour before. Facilities were quite inadequate; and, with Customs, immigration and baggage handling for 60 people all being conducted in a small room, something very close to chaos resulted. Moreover, the Brazilian bus drivers lost their way on the two-hour drive back into the city.

It seems certain that for some months at least BOAC will abandon its traffic stop at Rio de Janeiro in favour of the more satisfactory arrangements at Sao Paulo.

SAA ARE UNEASY

THE first uneasy rumblings of concern in South Africa about the traffic the national airline must find for its three Boeing 707s have become intensified now that introduction of economy-class fares is confirmed for October; to break even, SAA will have to cover operational costs of about £500 an hour. Among the dozen airlines using Jan Smuts the largest piston-engined aircraft carry about 50 passengers, and the South African Bureau of Census and Statistics has given a similar number per flight on the Johannesburg - London route. But over an average year it was calculated that end-to-end travellers numbered only 33 per flight.

Last March the South African Minister of Transport told Parliament that the Comet had been discarded because of range, speed and carrying capacity. Now it is Boeing capacity, a correspondent writes, that is a worry to the Minister and to South African Airways.

THE AIRLINES' SHOPPING LIST

ON page 56 appears the seventh of *Flight's* air transport shopping lists. Military, government and executive orders are included but options are not. Since the list was last published on April 17, 1959, it has had to be substantially revised. Among new aircraft included for the first time are the Canadair CL-44-D-4, for which orders have been placed by Flying Tiger and Seaboard and Western and for which an order by Slick is in prospect; the Avro 748, still with a slender order-book but with a satisfying arrangement for construction overseas; and the Handley Page Dart Herald, which appears on the list for the first time since

the prototype flew in 1958. Also new to the list are a number of new variants of familiar types, notably turbofan versions of the Boeing 707 (-120B and -020B) and the Douglas DC-8. New orders for variants of these big jets account for sales of another 25 aircraft, while others—already delivered—are to be converted. The Comet also appears with first orders for a new variant, the 4C, in demand by Compania Mexicana de Aviacion and more recently by Misrair. This brings the total of Comet orders to 42, with others in prospect (see col. 2 below).

One or two orders which appeared in April no longer feature on the present list, notably the Riddle Airlines' order for four AW.650 Argosies (which at the time of writing is not yet reconfirmed), while firm orders for Fairchild-built F-27 Friendships have been reduced from 90 to 78. The most recent F.27 order came as the list closed for press—five Fokker-built aircraft for THY, to be delivered to the Turkish airline at the end of this year and the beginning of next.

The substantial Viscount order-book has again increased, although at a reduced rate. There are now 51 Viscount operators in 32 countries and the first order for an executive version of the Viscount 810 has been announced—an aircraft for the Tennessee Gas Transmission Company. The Viscount order-book as written here refers to operators to whom new aircraft were delivered, but because of the large number of subsequent transfers it is not representative of current Viscount operators' fleets.

BREVITIES

Caravelles will be used by Air Algerie on their route between Paris and Algiers as from January 12.

Nine Convair 340s have been bought from United Air Lines by Napier Engines Inc. These aircraft are apparently independent of the aircraft Napier are supplying to Allegheny and they are reported to have a market value of about £120,000 each.

Because of air traffic congestion in Europe, Sabena is training Boeing 707 crews at Leopoldville in the Congo. The airfield is one of the longest in the world, with a runway length of 15,420ft. Sabena's first 707 was delivered to Brussels on December 21.

The freight services agreement between Air-India International and Seaboard and Western has been revised and extended until next August. Air-India will now take 15 per cent of the gross revenue instead of 20 per cent as originally agreed.

Since "The Airlines' Shopping List" (page 56) went to press, a repeat order for three Electras has been announced by Western Air Lines, bringing their total order to twelve. Two are to be delivered in July and one in August.

Because Aer Lingus have been unable to obtain from the Air Ministry the use of RAF Valley after March, the airline has suspended its scheme to operate an "air bridge" coach-air service between Dublin and Anglesey.

Capt A. S. Wilcockson, BOAC flight services manager, retired from the corporation at the end of the year. He made the first east-west commercial experimental flight across the North Atlantic in 1937 and was awarded the Johnston trophy by the Guild of Air Pilots and Air Navigators for his work in connection with North Atlantic services.

Imminence of the French A-bomb tests in the Sahara is suggested by Algerian Notam 3099, dated December 31, prohibiting an area round Reggan until further notice. An information circular of the same date says that a further Notam will be issued prohibiting over-flying of a "blue area" around Reggan about 300 miles across, in which flying up to 3,000m will be prohibited, and an outer "green area" about 800 miles across, in which flying above 3,000m will be prohibited.

Convair's FAA type certification programme for the 880 is about 60 days ahead of schedule. The test programme should be completed by March 1 instead of May 1 as originally planned.

There are indications that an order for de Havilland Comets may be placed by Middle East Airlines, whose chairman, Sheikh Najib Alamuddin, is to visit de Havilland next month.

Master Pilot certificates have been awarded by the Guild of Air Pilots and Air Navigators to Capt James Monro of BEA, assistant flight manager of the Viscount 802 fleet, and to Alan Smith, an instructor with Airways Aero Associations Ltd.

A BOAC Comet was damaged at Ciampino Airport, Rome, on December 23 as a result of a belly landing. First reports spoke of the undercarriage collapsing during the landing but they have not been confirmed. The most serious damage was to the flaps.

Capital Airlines are negotiating an agreement with PanAm to lease seven DC-6Bs with an option on a further four. Arrangements between Capital and Frederick B. Ayer to lease American Airlines' DC-6Bs have been dropped in favour of an agreement with PanAm. The latter airline's aircraft apparently require less modification to suit Capital's needs than those of American.

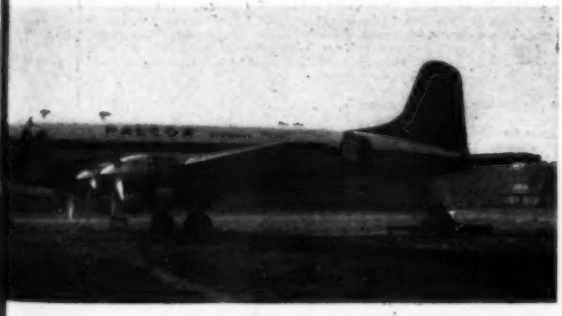
The first of ten spare Rolls-Royce Conways has been delivered by sea to Bombay for Air-India's Boeing 707-420s. Air-India is paying £75,000 each for these engines which, in the first two years of operation, will be overhauled by Rolls-Royce in the United Kingdom. Other powerplant units will be overhauled in Air-India's workshops at Santa Cruz Airport.

The Australian Government has given permission for "group charter" operators to charge an air fare between all countries with which Australia has a regular air service that is 30 per cent below IATA tourist class fares. The concession was announced by Senator Paltridge, Australian Minister of Civil Aviation. The fare between Sydney and London will be £184 16s compared with the tourist fare of £264.

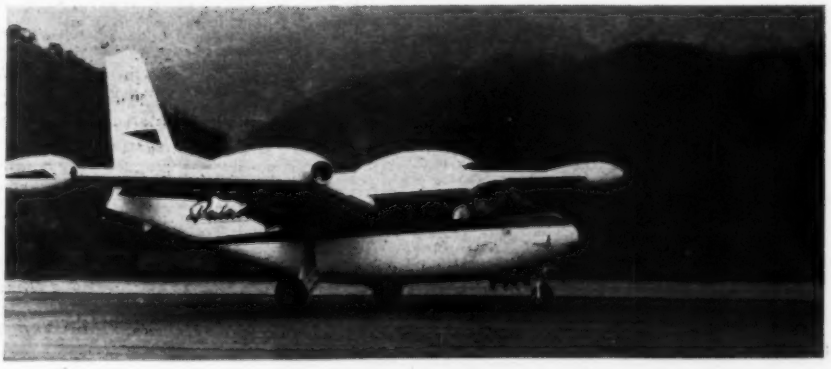
Bembridge Car Hire Ltd have purchased the entire assets of Independent Air Travel, including four Vikings and their ancillary equipment and spares. The machines are being flight cleared and will be offered for sale or for bare-hull hire, or the firm are prepared to lease them for "extremely short periods." A petition for the winding up of IAT, presented by Shell International Petroleum Co Ltd, is to be heard on January 11.

BEA has sold two D.H. Ambassadors (Elizabethans) to the Royal Jordanian Air Force after conversion by Marshalls at Cambridge (modifications included the fitting of a large freight door). The first aircraft was delivered on Boxing Day, picking up King Hussein *en route* at Rome. The second aircraft is due to be delivered next month. BEA are not prepared to state the value of the sale, but current market asking price, as quoted on Aircraft Exchange, is £70,000 per aircraft.

According to the *Daily Mail* Eric Rylands, managing director of Skyways and president of BIATA, considers that "one of the groups [of merged independents] should cover internal services." He added, "I have told the Minister one group could give a better service than at present and two could do more than BEA. As far as my airline is concerned, I believe we could fulfil a better role for British aviation by continuing our policy of working closely with the two corporations."



Now in the colours of Falcon Airways are two Hermes 4s previously owned by Airwork. This one is pictured at Blackbushe



Converted to a high-density ten-seater feederliner, this Piaggio P.166 has been bought by Patair—Papuan Air Transport Ltd., of Port Moresby. Before delivery the P.166 made a demonstration tour of Australia in the hands of Bristol Aircraft (Pty.) Ltd., Australian representatives of Piaggio

THE AIRLINES' SHOPPING LIST—No 7

(Correct to January 1, 1960. Comments, page 54)

Aircraft	Variant	Powerplant	Customer	Total
Airco D.H. 121		Rolls-Royce RB.163	BEA 24 (from late 1963)	24
de Havilland Comet	4	Rolls-Royce Avon RA.29	BOAC, 19 (current); Aerolineas Argentinas, 6 (current); EAAC, 2 (June 1960)	42
	4B	Rolls-Royce Avon RA.29	BEA, 7 (late 1959 to spring 1960); Olympic, 2	
	4C	Rolls-Royce Avon RA.29	CMA, 3 (from December 1959); Misrair, 3 (Summer 1960)	
Vickers VC 10	135 seats	Rolls-Royce Conway	BOAC, 35 (1963)	35
Boeing 707	-120	Pratt and Whitney JT3	PanAm, 6 -121 (complete); American, 25 -123 (complete; will be converted to 123B), 1 -123B test aircraft; TWA, 15 -131 (complete); Qantas, 7 -138 (complete); Cubana, 2 -139 (from March 1960); US Air Force, 3 VC-137A (complete)	148
	-220	Pratt and Whitney JT4	Braniff, 5 -227 (current)	
	-320	Pratt and Whitney JT4	PanAm, 17 -321 (current) 6-331 (diverted from TWA, current); Air France, 17 -328 (current); Sabena, 5 -329 (current); TWA, 12 -331 (current); SAA, 3- 334 (from July 1960)	
	-420	Rolls-Royce Conway	BOAC, 15 -436 (from January 1960); Lufthansa, 4 -430 (from January 1960); Air-India, 3 -437 (from January 1960); Varig, 2 -441 (from June 1960)	
Boeing 720	707-020	Pratt and Whitney JT3	United, 18 -022 (April 1960-April 1961); American, 15 -023 (from June 1960, will be converted to -023B); Irish Air Lines, 3 -048 (from November 1961)	49
	707-020B	Pratt and Whitney JT3D	American, 10 -023B; Lufthansa, 3 -030B (1961)	
Convair 880	Model 22	General Electric CJ-805	TWA, 30 (current-September 1960); Delta, 10 (January-September 1960)	48
	Model 22M		C.A.T., 1 (October 1960); Capital, 7 (October 1960-February 1961)	
Convair 600	Model 30	G.E. CJ-805-23	REAL, 3 (summer 1961); Swissair, 9 (2 for lease to SAS, March-July 1961); American, 25 (1961-62)	37
Douglas DC-8	Overseas or Long Range Domestic	Pratt & Whitney JT4	PanAm, 17 (current); United, 16 (current); KLM, 7 (early 1960); Eastern, 16 (early 1960); JAL, 4 (mid 1960); SAS, 7 (early 1960); Panagra, 4 (early 1960); Panair do Brasil, 4 (early 1960); Swissair, 3 (early 1960); UAT, 2 (mid 1960); TAI, 2 (mid 1960); Olympic, 2 (1961); Northwest, 5 (early 1960); National, 3 (early 1960)	92
	Domestic	Rolls-Royce Conway	TCA, 6 (early 1960); Alitalia, 6 (early 1960); CPAL, 4 (1961)	56
		Pratt & Whitney JT3	United, 21 (current); Delta, 6 (complete)	
		Pratt & Whitney JT3D	United, 3 (1961); KLM, 5 (1961); Iberia, 3 (1961); PAL, 2 (1961)	
Sud Caravelle		Rolls-Royce Avon RA.29	Air France, 24 (current); SAS/Swissair, 17 (current); Varig, 2 (current); Finnair, 3 (from February 1960); Air Algeria, 4 (from February 1960); Air Maroc, 1; Alitalia, 4; General Electric, 1	56
Avro 748		Rolls-Royce Dart RDa.6	Skyways, 3; BKS, 2; Indian Air Force, India holds a licence to build	5
Bristol Britannia	100	Proteus 705	BOAC, 15 102 (complete)	81
	250	Proteus 765	MoS, 3	
		Proteus 255	RAF, 20 255	
	300 series	Proteus 758/762	MoS, 1; Aeronaves de Mexico, 2 302 (complete); Air Charter, 2 307 (complete); Transcontinental, 2 308 (complete)	
	310 series	Proteus 765	BOAC, 18 312 (complete); El Al, 4 313 (complete); CPAL, 6 314 (complete), 2 324 (complete); Cubana, 4 318 (complete)	
		Proteus 757	Hunting-Clan, 2 317 (complete)	
Handley Page Herald		Rolls-Royce Dart RDa.7	MoS, 3 (for BEA)	3
Vickers Vanguard	950 series	Rolls-Royce Tyne	BEA, 20 (March 1960); TCA, 20 (August 1960)	40
Vickers Viscount	700 & 800 series	Rolls-Royce Dart	*See list below*	409
CL-44	-D-4	Rolls-Royce Tyne 12	Flying Tiger, 10 (1961); Seaboard & Western, 5 (1961); RCAF, 12 (CC-106)	27
Lockheed Electra		Allison 501	Eastern, 40 (complete); American, 35 (current); Braniff, 9 (current); National, 15 (current); KLM, 12 (current); Western, 12 (current); Allison, 1 (delivered); Garuda, 3 (August 1960); Pacific Southwest, 4 (current); Cathay Pacific, 2 (complete); Qantas, 4 (current); Ansett-ANA, 3 (first 2 delivered); TAA, 2 (complete); TEAL, 3 (current); Northwest, 18 (current); Capital, 5 (May-June 1960); TransAmerican Aeronautical Corp., 2 (early 1961); Private owner, 1	171
	P3V-1	Allison T56-A-10W	In production for the US Navy as ASW aircraft	
Fokker F.27 Friendship	Fokker-built	Rolls-Royce Dart RDa.6	Aer Lingus, 7 (complete); Braathens SAFE, 2 (complete); East-West Airlines, 1 (complete); Iran, HIM The Shah, 1 (complete); Iranian Oil, 2 (current); KLM, 2 (April 1960); Netherlands Department of Civil Aviation (Royal Flight), 1 (March 1960); Philippine Air Force, 1 (complete); Philippine Air Lines, 2 (February 1960); Royal Netherlands Air Force, 12 (1960); Trans-Australia Airlines, 7 (complete); Australian Department of Civil Aviation, 2 (complete); New Zealand National Airways, 4 (1960)	63
		Rolls-Royce Dart RDa.7	Ansett-ANA (including Butler Air Transport and Queensland Airlines), 6 (current); Helmut Horten G.m.b.H., 1 (complete); Mac.Robertson Miller, 1 (complete); Trans-Australia Airlines, 3 (complete); Pakistan International Airlines, 3 (1960); THY, 5 (1960)	
	Fairchild-built	Rolls-Royce Dart RDa.6	Aerovias Venezolanas, 5 (complete); Aloha Airlines, 6 (current); General Tire and Rubber Co., 1 (complete); Johns-Manville Corp., 1 (complete); Noland Co., 1 (complete); Northern Consolidated Airlines, 3 (complete); Ozark Air Lines, 3 (complete); Piedmont Airlines, 8 (complete); Quebecair, 3 (current); Reynolds Tobacco Co., 1 (complete); Trans Mar de Cortes, 1 (complete); West Coast Airlines, 6 (complete); H. K. Porter Inc., 1 (complete)	78
		Rolls-Royce Dart RDa.7	Aerovias Ecuatorianas, 1 (complete); Banco de Mexico, 1 (complete); Bonanza Air Lines, 10 (current); Butler Aviation, 1 (complete); Champion Spark Plug Co., 1 (complete); Continental Car Corp., 1 (complete); Ideal Cement Co., 1 (complete); Kimberly-Clark Corp., 1 (complete); Olin Mathieson, 1 (current); Pacific Airlines, 6 (complete); Raytheon, 1 (complete); Reynold Metal Co., 2 (complete); U.S. Steel, 1 (current); Westinghouse Electric Corp., 2 (current); Whitney, 1 (complete); Wien Alaska Airlines, 2 (complete); Murray Co., 1; Union Carbide, 3; undisclosed order, 1	
Fairey Rotodyne		Rolls-Royce Tyne	New York Airways, 5 (spring 1964)	5

Vickers-Armstrongs Viscount (all models). The following list of confirmed orders accounts for 409 aircraft, as follows: BEA, 27 V.701 (Dart 506); 24 V.802 (Dart 510), 19 V.806 (Dart 520); BWIA, 4 V.702 (Dart 506), 4 V.772; Aer Lingus, 4 V.707 (Dart 506), 6 V.808 (Dart 510); Air France, 12 V.708 (Dart 506); TAA, 7 V.720 (Dart 505/6), 7 V.756 (Dart 510), 2 V.816 (Dart 525); Indian Air Force, 1 V.723 (Dart 506), 1 V.730 (Dart 506); TCA, 15 V.724 (Dart 506); 36 V.757 (Dart 506); Hunting-Clan, 3 V.732 and 2 V.759, and 3 V.833; Pakistan Government, 1 V.734 (Dart 506); Iraqi Airways, 3 V.735 (Dart 506), 1 V.773 (Dart 506); Fred Olsen, 4 V.779 (Dart 510); Canadian Government, 1 V.737 (Dart 506), 1 V.797 (Dart 510); Misrair, 6 V.739 (Dart 506); Capital, 1 V.744 (Dart 506), 60 V.745 (Dart 510); Butler Air Transport, 2 V.747 (Dart 506); Central African Airways, 5 V.748 (Dart 510); LAV, 3 V.749 (Dart 506); MEA, 7 V.754 (Dart 510); Hong Kong, 2 V.760 (Dart 510); UBA, 3 V.761 (Dart 510); TACA, 1 V.763 (Dart 510), 1 V.786 (Dart 510); US Steel Corp., 3 V.764 (Dart 510); Standard Oil, 1 V.765 (Dart 510); Indian Airlines, 10 V.768 (Dart 510) KLM, 9 V.803 (Dart 510); Transair, 3 V.804 (Dart 510); New Zealand NAC, 4 V.807 (Dart 510); Continental, 15 V.812 (Dart 525); South African Airways, 7 V.813 (Dart 525); Iranian Airways, 3 V.782 (Dart 510); Lufthansa, 9 V.814 (Dart 525); Philippine Air Lines, 2 V.784 (Dart 510), 1 V.745 (Dart 510); Alitalia-LAI, 10 V.785 (Dart 510); South African Government, 1 V.781 (Dart 510); Pakistan Air Lines, 5 V.815 (Dart 525); Cubana, 3 V.755 (Dart 510), 3 V.818 (Dart 525); Lanica, 2 V.786 (Dart 510); Brazilian Government, 1 V.742, 1 V.789 (Dart 510); PLUNA, 3 V.769 (Dart 510); Eagle Aviation, 2 V.805; Turkish Airlines, 5 V.794; VASP, 5 V.827; Airwork, 2 V.736, 2 V.831; Ansett-ANA 4 V.832 (Dart 525); Northeast, 10 V.798 (Dart 510); Kuwait Oil, 1 V.776; Sudan Airways, 1 V.831 (Dart 525); Royal Bank of Canada, 1 V.793 (Dart 510); Tennessee Gas Transmission Co., 1 V.818.

South American Rentrée (continued from page 39)

obviously to BOAC's advantage to establish the Comet before the peak traffic season begins. The other reason is inter-related with the question of profitability. Exceptional steps are to be taken this year to obtain maximum utilization from the corporation's fleets and the opening of a new route is a useful step in this direction; in configuration, crew training and flight planning for the South American routes, Comet techniques are closely similar to those used elsewhere. And besides, although hopes of an immediate direct profit from Comet services to South America would be hard to justify, there are real gains to be achieved in generating greater traffic for other routes. Particularly is this true over the South America - Europe - New York triangle of routes on which Comet services now operate and which should feed the rich North Atlantic route and the good, though seasonal, demands of the Caribbean.

So, by taking the broad view, BOAC are optimistic about the commercial side of the revived route, and they have hopes that it will encourage the growth of traffic on other services, both around the Europe - Americas triangle and across the long route eastwards around the world to Tokyo and Australia.

When the service starts BOAC will be offering in common with but one other carrier—Aerolineas Argentinas—the only jet service to South America. As a service the popularity of the Comet seems assured; Aerolineas' Comet 4 achieved load factors of 69 per cent during their first months of operations. Comet operational altitudes have a welcome significance in South America, where over-weather flying carries a particular appeal to the regular passenger; nevertheless, the intertropical front can, and does, extend turbulence up to over 50,000ft.

What else can our national carrier offer to wrest a growing share of the thinly spread traffic? The answer is not to be found in the timetables, because Aerolineas Argentinas offer a more rapid end-to-end service (comparative block speeds and elapsed times are shown in the table below) and even faster services will be operated by the DC-8s and 707s.

COMET SOUTH ATLANTIC ROUTE FLYING TIMES
(hours and minutes)

British Overseas Airways Corporation					Aerolineas Argentinas		
London	↓	↓	2.45 ↑	2.15 ↑	London		.55
					Paris	1.05	1.55
					Frankfurt	↓	↑
Madrid	↓	2.05	↑	1.00	Rome		
Lisbon	2.45	1.00	4.05	4.05	Madrid	2.00	4.35
Dakar	4.10	4.10	4.35	4.35	Lisbon		
Recife	4.40	4.40	2.50	2.50	Dakar	4.35	4.30
Rio de Janeiro	3.00	3.00	.55	2.45	Recife	4.30	5.15
Sao Paulo	.55		2.20				
Montevideo	2.35	3.10	.40	.40			
Buenos Aires	.40	.40	—	—		↓	↑
					Buenos Aires	5.40	
Flying time	18.45	18.45	18.10	18.10	Flying time	17.50	17.10
Elapsed time	23.15	23.15	22.40	22.40	Elapsed time	21.50	20.55
Buenos Aires-Santiago	2.15	2.15	1.55	1.55			
Total flying time	21.00	21.00	20.05	20.05			
Total elapsed time	26.15	26.15	25.20	25.20			

There is a possibility that the third Comet service to South America will be a "cannonball" (a name coined to describe the fast BOAC service to and from the Far East) offering the fastest possible trip from London to Buenos Aires. Our friend the traffic manager in Sao Paulo suggested that here was an opportunity to offer the type of prestige service that would appeal to go-ahead elements in South American business and one which would best capitalize the particular advantages that BOAC now has to offer with the Comet.

This particular service might be all-first-class (40-60 seats) and serve only Rio de Janeiro (or Sao Paulo) and Buenos Aires, flying a route London - Lisbon - Dakar, 2,720 n.m. non-stop across the South Atlantic to Rio whenever possible, and down to Buenos Aires in an elapsed time of under 20hr—over an hour faster than the fastest schedule offered by Aerolineas Argentinas.

Where the corporation otherwise hope to score is in service, in regularity and punctuality, and in the good reputation of the British airline flying a British aircraft—all demanding standards that will require constant effort to maintain. So far in South America, BOAC advertising has been "strategic"—aimed at re-familiarizing the name BOAC and advancing the slogan ". . . . takes good care of you." The next stage—which will be under way when these words appear—is the tactical step of advertising the Comet 4. This has been something of an exercise in logistics, because Argentina and Brazil do not allow printed advertising matter to be imported and printing blocks have had to be flown in and printers found locally. Nevertheless the results have been satisfactory, although more emphasis might be given, one feels, to the word "jet" and to promoting a sense of stability and permanence to BOAC's renewed service.

In common with other routes, BOAC are also recruiting stewardesses locally, and a number of Brazilian, Uruguayan and Chilean girls are now being trained in England. Thus, in the short time that the Comet has jet ascendency, the BOAC cabin staffs will again be dispensing from the famous silver trolley the BOAC service that is one of the carrier's *cachets*, and is important because every advantage in prestige is important under intense pressure of competition.

Yet in the context of the three proving flights that preceded the opening of South Atlantic route services, it was less the *quality* competition of the big jets ("Will they *really* be put on this route in 1960?" was the rhetorical question frequently put by station staffs along the route) than *price* competition from rate under-cutting that was the chief concern of station and traffic managers. "It could not have been more unfortunate," the BOAC manager in Santiago observed, "that the rate war should have blown up when it did, just as we were trying to get services under way. We don't believe that it did anything to help us off to a good start and we are landed with scores of open-dated tickets, all valid for a year." In fact, the effect has varied from place to place; about 1,200 cut-rate tickets have been sold, 700 of them in Buenos Aires. But although Sao Paulo and Rio between them account for about 30 per cent of the northbound South Atlantic traffic (in the ratio of about 40:60 between the two cities) only about 100 seats were sold in Brazil at the discount price; business concerns did little speculative buying of open-dated tickets at cut rates.

Is the rate war over? It seems that for the moment it is; and that however uneasy the armistice signed in Paris on November 24, it is being observed. But South American airline sales offices are keeping a wary eye open for discounts offered by their competitors and if undercutting starts again all would be quick to follow suit. Then all the IATA enforcement officers in the world could not piece the situation together again.

In a continent as large and as politically, geographically and economically varied as South America, there are too many local facets to present more than a general summing up of the commercial considerations of BOAC's new South American service. But in broad terms, it might be put this way: The corporation have perhaps seven or eight months with jet competition from only one other carrier; thus it is clearly most important that the initial promotional effort should be intense if BOAC are to become quickly and firmly re-established in South America. Cabin service and ground handling will assume particular importance if the airline is to be sold successfully; not every carrier has the slickness here that BOAC hope to demonstrate. The traditional Lancastrian/Tudor/Argonaut route may no longer be the right one for the Comet, the speed and appeal of which must already be causing concern to other airlines' sales offices. The most important consideration to the traveller from Buenos Aires or Rio may not be flying speed but elapsed time; a streamlined, possibly all-first-class cannonball operation looks attractive, and it is in keeping with the mushrooming growth, the modernity and pace of the bigger South American cities. When there is big-jet competition on this route BOAC must change its attack from selling speed to selling frequency; this may make desirable an integration with Aerolineas Argentinas. The Comet seems to be just the right size of aeroplane with which to offer frequency-competition on this route.

Rain at Carasco, Montevideo's international airport, as the Comet is turned around for the short leg to Buenos Aires

More and more capacity is becoming available to satisfy the big potential demand for very-low-fare air transport

THE KEY TO "VLF"

By J. M. RAMSDEN

Inquiry into the Very-low-fares Controversy: Part Two

PART One reported what might be termed the "official view" in East and Central Africa concerning the very low fares proposed by three British independent airlines. A table opposite lists these very low fares (which have come to be known, in this age of initialese, as "VLF"). This article records the views of the VLF proponents, and suggests a possible solution to the great controversy.

WHEN, just over a year ago now, Eagle sprang their big VLF surprise, they touched off a controversy which indirectly caused the first open cracks to appear in IATA's international fare structure. At home, as *Flight* noted, the repercussions were immediate:—

"The initials VLF stand for more than very low fares: they symbolize the efforts of the British independents to surmount the obstacles to their expansion and progress. Because these obstacles are no less than the interests of the two airways corporations, the initials VLF may be said also to signify a challenge to the structure of British air transport."

It is this structure which Parliament may soon be asked to modify, since it seems that VLF can only be introduced by changes in the Civil Aviation Act.

The previous article recorded the VLF views of Government and "establishment" airline officials in the British cabotage territories of East and Central Africa—routes, it was submitted, which hold the master key to the solution of the VLF controversy. Summing up these views, it can be said that the basic objection to the introduction of VLF by the independent airlines is that such services will divert traffic from the established carriers, disrupting the pattern of existing air services to the detriment of the public interest and of the established airlines themselves.

No one on the official side was in fact able to produce convincing evidence that VLF would divert traffic from the established carriers to a degree material enough to disrupt existing services. Similarly, no one among the proponents of VLF was able to offer convincing evidence that VLF would *not* materially divert traffic from the established scheduled services. Whereas Colonel M. C. P. Mostert of EAA reckons that more than 80 per cent of his business will be diverted by VLF, Denis Mathews of the East Africa Tourist Travel Association, and a member of the Air Transport Licensing Advisory Board, estimates that 80 per cent of VLF traffic will be new traffic. Each of these men is using his own highly respected judgement, based on many years' professional knowledge of his business. The divergence of these opinions is the essence of the VLF controversy.

It has been said many times that the extent to which any low fare service will cause "material diversion" defies estimation. For seven years Airwork and Hunting-Clan have been operating, at a fare level of about 15 per cent below the established IATA tourist levels, Colonial coach services on the cabotage routes from the UK to East and Central Africa. Together these services represent about a third of the low-fare traffic to and from East Africa. It seems reasonable to suppose that some of this traffic was new traffic which would not otherwise have travelled by air, whilst the remainder would have travelled at the 15 per cent higher fare with the established carriers.

Yet there has been no detailed consumer research which might have produced some hard evidence to support or refute the contention that the majority would, in fact, have travelled at the higher fare with the established carriers—thus causing material diversion. At the VLF hearings which took place in public in Nairobi last April only the sketchiest evidence was submitted by BOAC and EAA to support their contention that Colonial coach services had diverted their traffic. Airwork and Hunting-Clan contested this evidence, though they produced no market research evidence in support of their arguments.

Since material diversion is the essence of the VLF controversy, and since the African route concerned has for seven years been a low-fare test case, it seems surprising that the parties concerned could offer no real evidence in support of, or in refutation of, material diversion. However, irrespective of market research, and regardless of whether the lack of it is unfortunate or not, the VLF challenge remains.

Let us hear the VLF views of Hunting-Clan and Airwork, since they are the independents most closely concerned with the African routes—notwithstanding Eagle's "prior claim." From the head of Hunting-Clan, Maurice Curtis, we sought HCA's views on the VLF controversy. Mr. Curtis considered that VLF was an "inevitable development" in the pattern of air transport. To oppose it "would be to halt progress and to deprive the public of a great benefit." Such low fares were inevitable sooner or later—" and if passengers are going to be diverted from sea to air transport the sooner they start changing to British-operated, as opposed to foreign-operated, aircraft the better." Finally, he was quite emphatic that VLF would be profitable.

The big question that must be perplexing HCA is the future of their Colonial coach services to Africa when the corporations introduce economy fares between the UK and Nairobi and Salisbury. Viscounts obviously cannot compete with Britannias at the same fare. Is there no alternative, apart from VLF? Possibly HCA's Viscount 833s could stand a fare cut of about 10 per cent; but the resulting discount on the corporations' proposed economy fare would amount to only 3 or 4 per cent—a differential which would obviously be insufficient to maintain the traditional "15 per cent discount" appeal of Colonial coach.

No one in HCA considers that the previous Minister's idea of a 30/70 per cent (independents'/corporations') share of the future economy fare traffic would be acceptable. And one finds little enthusiasm for the concept of "paralleling BOAC's routes" on the basis of parity in fares and equipment. This leaves two opportunities for HCA's expansion: (1) Creation of the sphere-of-influence concept, whereby selected routes are reserved to an independent like HCA for full development throughout the fare scale; or (2) VLF.

The sphere of influence concept would probably be the most acceptable. The French have successfully managed to introduce this idea, with UAT and TAI developing, respectively, France's African and Pacific spheres of air transport influence. But it is unlikely that this will become an issue in the UK.

So far as VLF is concerned, HCA appear to be absolutely convinced about its profitability.

Here it is worth interjecting an old HCA idea: carriage of low-fare passengers on freight services. Today this would mean developing DC-6C all-freight services ("Africargo") into mixed-traffic (freight plus VLF passengers) form. The Africargo service is probably not unlike other all freight services in being marginally profitable—though the operating account probably began to look brighter when Yorks were replaced by DC-6Cs. Certainly VLF passengers travelling behind partitioned-off livestock, pineapples and mining equipment would not object to the inevitably lower standards of comfort, or to routings and schedules that would be primarily aimed at satisfying the needs of the freight market. There seems, indeed, to be scope for the development of mixed-traffic VLF on other world routes. It would put freighting on a

sounder economic basis, and the VLF demand would be at least partially met—though not so fully as on the basis of the all-VLF capacity HCA has applied for. Mixed traffic VLF would be a compromise.

Hunting-Clan's manager in Nairobi, Bill Urry, like Mr. Curtis, leaves one with no shadow of doubt about his company's determination to introduce VLF, or as to its profitability. The most significant evidence of this was a letter he distributed a few weeks ago to his many potential low-fare customers. It had been "spread around" that the solution to the VLF controversy might be a UK - East Africa return fare of £150—i.e. a compromise between the £100 VLF and the £200 Colonial coach or economy class fare. Here, in part, is his statement:—

"Many months have gone by since our application for a licence to fly a Very Low Fare service was heard in Nairobi. I am writing now first of all to reassure you that Hunting-Clan's plans are still unchanged. We have no intention of withdrawing our application nor do we wish to compromise on any fare higher than £100 return.

"Secondly, I want to try to clear up any confusion which may have been caused by the recent reports in the newspapers of discussions at international air conferences about reduced fares on the African routes. Vague statements have been quoted and the impression might be left that these reduced fares bear some relation to the application for Very Low Fares made by Hunting-Clan and other operators. This most emphatically is not the case. Certain national airlines have put forward proposals for an economy class service at about 20 per cent below their current tourist class fare but this would mean a fare of about £187 Nairobi/London return, or little less than our existing fare. . . ."

This certainly dispels any doubts there might have been that HCA's VLF proposals were merely "copycatting Eagle" (which was suggested at the Nairobi VLF hearings) for political reasons, and that they are really only lukewarm about the idea. It might be asked why HCA did not come forward first with VLF: the answer to that must be that Eagle provided the competitive stimulus. HCA readily acknowledge the lead given by Eagle, though they will not concede that independent's prior claim.

Airwork's Caution

Airwork are more cautious about VLF—not about their rights to introduce it if anyone introduces it (their spokesman at the Nairobi hearings, K. R. Sangster, made this plain), but about its economics. We sought the views of M. D. N. Wyatt, managing director of Airwork. He agreed with the suggestion that his African Colonial coach services would have to be withdrawn when BOAC introduced its economy class fares. He considered that a fare reduction of about 10 per cent might be economically feasible with Viscount 833s, but he did not see much commercial sense in such a service. Would he accept a cut of the new economy class business? Unlike airlines which, he said, did not have to worry too much about making a profit, he could not order the necessary new equipment "just like that." He had to make his Viscounts pay for themselves; he could not just scrap them in the insane way that subsidized airlines scrapped their equipment. "My job is to see that Airwork makes a profit, to think in terms of Airwork's interests first and foremost."

Mr. Wyatt was doubtful whether a cut of the economy class business would be acceptable, nor did he warm to the idea of Airwork being given so called reserved spheres of influence in which to develop international services. His views on the economics of VLF were likewise circumspect; Airwork wanted its share of whatever was granted, but his remarks did not conflict with what was said in *Flight* on May 1, 1959, page 620;

"Though Airwork and Hunting-Clan followed the Eagle moves with a series of similar applications it is not absolutely certain that *both* airlines [italicized here] are completely confident about the economics of VLF. . . ."

On the question of possible independent mergers, we asked Mr. Wyatt whether the bridge which already existed between Airwork and HCA—Colonial coach partnership and substantial subcontracting by Air Charter to HCA's long-term Government trooping contract—might lead to a merger? His reply was non-committal, though he did not positively rule out the possibility of a merger if it appeared to be in Airwork's interest.

In Nairobi we were received by Tom Lockhart-Mure, who looks after Airwork's interests in East Africa, and who is general manager of Airwork (East Africa) Ltd. Was he "flat out for VLF?" He replied: "If VLF is approved, and I do not personally think it will be, we shall be flat out to introduce it." He thought it was wrong that the public had been given the impression that such low fares were just around the corner. He considered that "we have definitely lost traffic" because of the prevaricating over VLF. He could not put a figure on this, but Colonial coach traffic had been "very up and down." It was not Airwork's policy to provoke—"we don't hold with the down-with-the-corporations brigade. There is room for both of us."

At this stage it is as well to sum up the case for and against VLF as recorded in this and the previous article:—

East African Government: VLF welcome, provided there is no disruption of EAA's services, and provided EAA get their share.

East African Airways: VLF not likely to create much new business, and in any case it is totally uneconomic. But EAA demand their share, with losses to be made good out of subsidy.

East Africa Tourist Travel Association: Flat out for VLF, which would be 80 per cent new business. Decision needed quickly, as "dithering" has caused a travel recession.

Central African Government: VLF welcome, provided there is no disruption of BOAC's services.

Central African Airways: Doubts about the new market that VLF would create, but CAA demands its rights to a share, perhaps through its arrangement with BOAC.

Eagle: Pioneer of VLF, and insisting on its "prior claim." Meanwhile planning to operate VLF services as "closed group" charters.

Airwork: A claimant with apparent misgivings about VLF's economics, but a determined claimant nevertheless, with well established low-fare Colonial coach services in Africa, now threatened.

HCA: 100 per cent in favour of VLF, also with well established, but now threatened, low-fare African Colonial coach services *and* scheduled freight services to Africa.

Public opinion: Why are we waiting?

THE VLF APPLICATIONS

From London to	EAGLE (Application: December 1958)		HCA/AIRWORK (Application: February 1959)		
	Return fare	Initial frequency	Return fare	Initial frequency	Lowest IATA Tourist Return fare
Aden	£107	fortnightly	£107	fortnightly	£217 16s
Bahamas (Nassau)	£140	fortnightly	£135	fortnightly	£231 10s
Bermuda ...	£124	four per week	£131	fortnightly	£218 13s
Gibraltar ...	£21 4s	monthly	—	—	£38 15s
Hong Kong ...	£246	fortnightly	£245	fortnightly	£415 16s
Jamaica (Kingston) ...	£150	fortnightly	£150	fortnightly	£252 15s
Kano	£82	fortnightly	£83	fortnightly	£165 12s
Lagos	£93	fortnightly	£95	fortnightly	£187 4s
Malta	£19	weekly	£30	twice-weekly	£42
Nairobi	£101	fortnightly	£100	twice-weekly	£234
Nicosia	£41 15s	weekly	—	—	£108
Salisbury ...	—	—	£145	weekly	£264
Singapore ...	£199	fortnightly	£199	fortnightly	£363 12s
Trinidad ...	£165	fortnightly	£165	fortnightly	£283 10s

Note. Eagle's application assumes the use of DC-6Cs, fitted with 100 seats on the routes to Aden, Gibraltar, Kano, Lagos, Malta, Nairobi and Nicosia; and 88 seats (with crew rest bunks) on the routes to the Bahamas, Bermuda, Hong Kong, Singapore and Trinidad. The HCA/Airwork applications assume the use of 101-seat DC-6Cs or alternatively 127-seat Britannia 300/310s.

Note 2. Although HM Government have made no decision on the VLF applications, the following is a summary of the decisions made by the Colonies concerned: Aden, Eagle application approved; Bahamas, Eagle application approved; Bermuda, application by Eagle Airways (Bermuda) for VLF services to London approved; Gibraltar, decision rests with HM Government; Hong Kong, Eagle application approved; Jamaica, hearings held but no decision made; Kano and Lagos, no hearings held—cabotage rights cease with independence in October 1960; Malta, Eagle application approved; Nairobi, hearings held but no decision made; Nicosia, application rejected—cabotage rights cease with independence in February 1960; Salisbury, hearings held but no decision made; Singapore, no hearings held—decision left to HMG; Trinidad, no hearings held—decision left to HMG.

Note 3. HCA/Airwork's applications include certain cabotage traffic stops not included above, as follows: Entebbe (£98); Ndola and Lusaka (£140); Montego Bay (£150); Kingston (£150); Antigua (£140); Barbados (£160).

To all these views must be added those of BOAC (and, though less involved, BEA). We invited BOAC's opinion on VLF: Keith Granville, deputy managing director, gave *Flight* his views in a conversation reported in the issue for December 4. He made it quite clear that BOAC was totally and absolutely opposed to the independents' VLF applications. BEA's views are similar.

What of the Ministry of Aviation? It is possible that there are people in the Ministry, of the calibre of M. M. V. Custance for instance, who have arrived at well reasoned and enlightened policies concerning VLF. Such policies, if they indeed exist, are now before a Minister with the decisiveness of Duncan Sandys, who has said: "I hope that we shall be able to work out solutions which will give some reasonable satisfaction to both parties."

The VLF problems have been outlined: what shall be the solution to them which will give "reasonable satisfaction to both parties"? As with all controversies, a settlement will require some give and take on both sides.

It is suggested that the VLF proposals must be accepted in principle, for the following reasons:—

(1) VLF will satisfy an undisputed public demand.

(2) If it is not accepted, ways will be found to introduce "pirate" VLF.

(3) There has always been a case for cut-rate secondary air services, carefully regulated so as to avoid disruption of the regular services.

(4) This case is proven by the success of the independents' Colonial coach services. "Diversion" is alleged, but such services are in fact now operated by the "establishment" airlines EAA and CAA, and they have unquestionably accelerated BOAC's economy class plans.

(5) The place of cut-rate Colonial air services is now threatened by the introduction of regular economy class fares, and Colonial coach can only be kept alive if its operators are allowed to downgrade fares also (and to operate types which will make such downgrading economic).

THE KEY TO "VLF"...

(6) A downgrading to the extent of VLF is unprecedented; but the greater the downgrading the greater the chances that the traffic attracted will be new, rather than diverted, traffic.

(7) VLF is considered economic by at any rate two of its proponents. These two are low cost operators, and it is important that such operators should be allowed to pass on to the public the benefits of their low costs, and to maintain low fare pressures on the established carriers.

(8) It it worth remembering that the US system of regulation permits "supplemental carrier" scheduled air services at cut rates and low frequencies on domestic routes. Regulation is such that there is no disruption of the regular services.

(9) Britain has every right to take advantage of considerable Colonial cabotage privileges to develop her own "supplemental" cut-rate services as an integral part of her air transport system.

(10) VLF, by creating business for prematurely obsolescent but still economic aircraft, will provide a healthy corrective—small but influential—to air transport's obsession with quality competition.

(11) If it is right for the Government to approve State corporation investment in the most advanced and competitive equipment, it is right for it to encourage the use (by corporations as well as by independents) of second-line but still economic equipment.

(12) VLF, to repeat (1), will satisfy an undisputed public demand. It will create new business for British air transport, and it will keep the attention of a whole industry—corporations, independents, aircraft manufacturers and government departments—focussed on the mass market on which the future prosperity of all depends.

But how can VLF be introduced? No one wants the established services to be operated with rows and rows of empty seats, causing the corporations heavy losses which will eventually mean either a withdrawal or a public subsidy. There is little sense in risking the disruption of air services carefully built up over a quarter century, like those of BOAC—an airline with more experience of international airline operations than all three VLF proponents put together. Mr Sandys has said: "It is not my intention to do anything which will undermine BOAC or BEA, in which so much public money has been invested. They must continue to be Britain's principal flag carriers on the main air routes of the world. But there is scope also for the independents to expand."

The solution, as presupposed in the dozen points above, lies in regulation. And regulation requires some definition of the meaningless cant "material diversion." If it is fear of this which is at the bottom of every controversy over independent low-fare bids, ought we not to seek some formula whereby it can be scientifically assessed?

Such a formula can be derived from experiment and inquiry. For seven years there has been the Colonial coach experiment, yet the Ministry has prompted no systematic inquiry into the kind of traffic it has attracted. The knowledge about diversion that such research* might have yielded could have been put to good use in the VLF controversy.

A Basis for Regulation

Meanwhile the basis upon which VLF should be regulated can be determined from what experience is available. For example, we can find the relationship between the traffic carried on Colonial coach services and the traffic carried on parallel corporation tourist services. In 1958, taking the UK-Nairobi routes as typical, the picture was as follows (passengers southbound):—

Airwork	Hca	Boac/Saa/Eaa†
1,661	1,763	6,895

The relationship works out as 33 per cent Colonial coach and 67 per cent BOAC/SAA/EAA. The relationship in terms of *capacity*, since the corporations' load factors are lower than those of the independents (71 per cent for HCA in 1958), would be of the same order. It is interesting to see how closely this accords with the 30/70 division recommended by the Government in 1957 as the independents'/corporations' share of the future economy class market.

Now in its 1957-58 report BOAC said that, as a result of Viscounts being introduced on Colonial coach services in 1957, these services "have caused increasing inroads into the traffic carried on the tourist services of the corporation and its partners." No measure of these inroads was offered; but it seems that a 33 per cent independent share of the low fare market is the highest that BOAC and its partners could reasonably be expected to bear on any route initially—particularly in view of the fact that VLF will be operated not by Viscounts, but by more competitive (from the long-haul viewpoint) Britannias or DC-6As.

No figures are available, except within BOAC, to show the point-to-point tourist traffic carried by the corporations on the routes affected by the VLF applications. Reference to timetables gives only a rough idea of the extent of the corporations' tourist traffic. One can estimate how many tourist seats are offered from London to, say, Singapore weekly. But we do not know the origin or destination of the passengers occupying these seats. Nevertheless, a very rough assessment does suggest that on certain routes anyway the VLF applications (either Eagle's or HCA/Airwork's) represent a higher percentage of the low fare market than has generally been supposed—perhaps as high as 50/50 on the routes to Aden and the Caribbean.

Will the proposed African frequencies, operated by 100-seat DC-6As or 127-seat Britannias, command more than a 33 per cent share of the low fare market? Since we do not know how much economy class and tourist class capacity the corporations are proposing to provide on the African route, we can only guess. Will 10,400 seats a year to Nairobi (for example) represent more than 33 per cent of the total low fare market? Such questions, which can only be answered by an authority with all the facts and figures made available to it, are fundamental in any consideration of the extent to which VLF should be regulated.

Something else that is fundamental in any attempt to solve the VLF problem emerged clearly from the first article: the African corporations EAA and CAA insist on their rights to a share in VLF. It is conceivable that the two UK corporations (in particular, BOAC) are now—having understandably opposed the independents' VLF applications—likewise saying: "If anyone is to get VLF, we insist on our share." BOAC might be prepared to operate their impending very big surplus stock of DC-7Cs and Britannias on a marginal cost basis at VLF (or, by a compromise with the independents, not-quite-so-VLF) rates. By chartering capacity to their partners, BOAC could then enter the VLF (or not-quite-so-VLF) field alongside the independents—either in addition to their proposed economy class or (more sensibly perhaps) instead of it. This is perhaps a revolutionary idea: but the potential VLF market would sustain both VLF producers, and regulation would be straightforward. It might all depend upon whether the independents would be prepared to compromise on a slightly higher VLF rate, and whether BOAC would be prepared to have a go at operating their surplus propeller equipment on a marginal cost basis. Certainly BOAC's surplus stock has to be put to good account somehow.

Which independents should be licensed for which VLF routes? Suffice it to suggest that, though Eagle are the inventors of VLF, their "prior claim" to the key African routes should not be at the expense of the established independents—operators which can, incidentally, claim to be the pioneers of Colonial coach scheduled air services. Certainly there will have to be give-and-take (or mergers?) among the independents, as well as between them and the corporations.

It is likely that, if the Civil Aviation Act is amended to allow VLF to be introduced by any independent (the corporations are unlikely to sign the necessary associate agreement required by law at present), responsibility for its regulation will be invested in the proposed new Air Transport Board. The constitution of this Board will be a subject of a later article. It is undoubtedly VLF which more than anything else has shown how great is the need for such a board—for an executive referee to take Britain's air transport field. When the whistle has blown for VLF to be introduced, there must be created a body capable of resolving the next fares challenge when it arises.

For three ten-day periods each year since 1949 Aer Lingus has invited passengers to answer questions devised to determine the commercial characteristics of its market. From personal interviews there has been a 90 per cent response, from questionnaires on the aircraft 70 per cent.

†In the last weeks of 1958 EAA introduced a weekly Canadair Coach service. This has been ignored in the accompanying rough comparison.

SUMMARY AND CONCLUSIONS

- The VLF principle should be accepted, for the dozen reasons suggested.
- The main objection to VLF—diversion from corporations whose business must not be undermined—could be met by skilful regulation.
- Colonial coach experience suggests, as a basis for such regulation, that the independents' share of the low fare market might be about one-third, at least initially.
- This may, on some routes, require the independents' VLF demands to be curtailed—*unless* the corporations also introduce VLF (perhaps instead of economy class, and perhaps at a compromise fare rather higher than VLF) by operating their big surplus of DC-7Cs and Britannias at marginal cost.
- Corporation participation would, paradoxically, increase the independents' VLF scope, because regulation need consequently be less protective towards the corporations.
- Responsibility for regulation should be invested in the proposed new Air Transport Board, which should sponsor field research aimed at establishing a much needed formula for estimating the diversionary effect of low fares.
- Whether the corporations insist on "we too" VLF or not, selected independents should be granted a VLF franchise.

A Javelin FAW.7, with air brakes extended, seen from the cockpit of another FAW.7 in close formation. For the origin of this picture, taken during a ceremonial fly-past over one of the world's most famous cities, see the story on the following page

SERVICE AVIATION

NEW YEAR HONOURS, AWARDS AND PROMOTIONS

RAF Promotions—

FOUR new air marshals are named in the list of half-yearly RAF promotions which took effect from January 1. Promoted from air vice-marshal, they are H. P. Fraser (seniority July 1, 1959), UK representative on the permanent military deputies group, CENTO; Sir Walter Cheshire (seniority July 1, 1959), AOC Malta; H. D. McGregor, AOC-in-C Fighter Command; and Sir William Macdonald, C-in-C MEAF.

Eight new air vice-marshals are named, promoted from air commodore. In the GD branch they are P. D. Holder, AOC Hong Kong; A. Foord-Kelcey, AOC No 11 Group, Fighter Command; C. Scragg, AOC No 23 Group, Flying Training Command; H. J. Maguire, AOC No 13 Group, Fighter Command; R. N. Bateson, ACAS (Operational Requirements), Air Ministry; and P. G. Wykeham, AOC No 38 Group, Transport Command. In the technical branch, H. Ford, STSO Flying Training Command; and T. U. C. Shirley, STSO, Fighter Command.

—and Honours

BELOW is a full list of the 189 RAF, RAFVR and WRAF officers, NCOs and ORs who have received honours and awards in the New Year Honours:—

Honours

ORDER OF THE BATH

Knight Grand Cross: Air Chief Marshal Sir Harry Broadhurst, KCB, KBE, DSO, DFC, AFC.

Knights Commanders: Acting Air Marshal W. H. Kyle, CB, CBE, DSO, DFC; Acting Air Marshal H. D. McGregor, CB, CBE, DSO.

Companions: Acting Air Marshal S. C. Elworthy, CBE, DSO, MVO, DFC, AFC, BA; AVM E. M. F. Grundy, OBE; Acting AVM R. W. L. Glenn, CBE; Air Cdre T. N. Coslett, OBE, MIMechE; Air Cdre E. M. Donaldson, CBE, DSO, AFC; Air Cdre E. G. Jones, CBE, DSO, DFC; Acting Air Cdre R. T. Gething, OBE, AFC; Acting Air Cdre R. I. Jones, AFC.

ORDER OF THE BRITISH EMPIRE

Knights Commanders: Air Marshal H. D. Spreckley, CB, OBE, MIMechE, FRAeS; AVM G. L. Worthington, CB, CBE.

Commanders: Air Cdre W. P. Stamm, QHS, MB, BS, FRCP, MRCS, DCP, DTM&H; Gp Capt H. J. Cundall, DSO, DFC, AFC; Gp Capt W. R. Ford; Gp Capt D. B. Hatfield; Gp Capt J. E. Johnson, DSO, DFC; Gp Capt T. W. Kean, OBE, AFC; Gp Capt T. King; Gp Capt J. F. Roberts, OBE, ACA; Gp Capt J. B. Russell, DSO, OBE; Gp Capt B. D. Sellick, DSO, DFC; Gp Capt R. D. Stubbs, DFC.

Officers: Wg Off M. F. Arkell, WRAF(Ret.); Wg Cdr H. C. D. Blasbery; Wg Cdr A. D. Button, BSc, AFRAeS; Wg Cdr F. S. Hazlewood, AFC; Wg Cdr R. Hill, AFRAeS; Wg Cdr L. Kendrick, AFRAeS; Wg Cdr T. Knight; Wg Cdr G. E. Langley (Ret.); Wg Cdr E. B. Loftus; Wg Cdr T. P. McGarry, DFC; Wg Cdr A. J. Peart; Wg Cdr A. J. Scott, DFM; Acting Wg Cdr B. S. Jones, DSO, DFC; Acting Wg Cdr C. E. Whitaker, RAFVR (Training Branch); Sqn Ldr W. G. Didcote; Sqn Ldr G. A. Harrison; Sqn Ldr K. G. Hodson; Sqn Ldr P. L. Kelly, BEM; Sqn Ldr J. L. Wallace, MBE, LRAM, ARCM.

Members: Sqn Ldr F. C. Airey; Sqn Ldr (Acting Wg Cdr) H. E. Bennett; Sqn Ldr J. Cartwright; Sqn Ldr H. D. Elmes; Sqn Ldr C. J. W. Herold; Sqn Ldr A. Perry; Sqn Ldr H. H. Pickard, BSc; Sqn Ldr H. C. Scott; Sqn Ldr P. F. Smith; Sqn Ldr J. A. Steff-Langston; Sqn Ldr R. Stephens; Sqn Ldr T. J. Thomas; Sqn Ldr B. Trodd, AFRAeS; Acting Sqn Ldr J. Baseley; Acting Sqn Ldr R. D. C. J. Pitman, RAFVR (Training Branch); Flt Lt R. K. D. Cooper; Flt Lt L. C. Eagle; Flt Lt W. H. Ellyard; Flt Lt T. H. French; Flt Lt J. Gant DFM, DPhysEd; Flt Lt R. Jackson, DFM; Flt Lt D. J. Jones; Flt Lt R. J. Kingdom; Flt Lt A. O. Lucas; Flt Lt A. R. B. Pointer; Flt Lt R. G. Robertson; Flt Lt P. A. Spencer; Flt Lt W. W. I. Walker; Acting Flt Lt E. F. Hares, RAFVR (Training Branch); WO C. Ball; WO H. V. Barling; WO D. Broughton; WO J. R. Doody; WO C. P. Gilbert; WO R. A. Green; WO G. Gwilliam; WO R. Proudlove; WO H. Pulford; WO A. C. St. Q. Sansom; WO E. Thomas, RAF Regt; WO J. W. Walters; WO D. A. Warnett; WO R. E. Watkins; WO J. Webb (Ret.); WO R. L. Williams.

Awards

Bar to Air Force Cross: Acting Wg Cdr A. W. Ringer, AFC; Sqn Ldr T. L. Kennedy, AFC; Cdr K. R. Hickson, AFC, RN.

Air Force Cross: Wg Cdr M. J. Beetham, DFC; Wg Cdr C. M. Fell; Wg Cdr D. F. Rixson, OBE, DFC; Sqn Ldr F. G. Agnew; Sqn Ldr G. C. Cairns; Sqn Ldr R. J. F. Dickinson; Sqn Ldr T. R. Holland; Sqn Ldr R. D. Mullins; Sqn Ldr L. W. Phipps; Flt Lt D. S. Burden; Flt Lt J. G. Davies; Flt Lt D. Draper; Flt Lt E. E. Fell; Flt Lt A. J. Harris; Flt Lt D. M. L. Lob; Flt Lt H. McMaster, AFM; Flt Lt B. P. W. Mercer; Flt Lt L. Simpson; Flt Lt R. A. Stenning; Flt Lt W. C. Wood, AFM.

Royal Red Cross (Second Class): Sqn Off E. H. R. Macdonald, Princess Mary's RAF Nursing Service; Flt Off R. A. Penrose, Princess Mary's RAF Nursing Service.

Air Force Medal: F/sgt J. A. Mears.

British Empire Medal (Military): F/sgt F. H. Baker; F/sgt D. C. Bushnell; F/sgt K. W. E. Chambers; F/sgt A. B. Chapman; F/sgt E. Clark; F/sgt T. C. E. Meek; F/sgt J. G. R. Prag; F/sgt E. V. Prince; F/sgt A. Severn; F/sgt F. A. Smith; F/sgt J. P. Smith; F/sgt W. R. Spray; F/sgt T. Z. Stepniewski; F/sgt J. M. White; Ch Tech A. E. Caves; Ch Tech F. E. Dack; Ch Tech N. C. Devereux; Ch Tech E. I. R. Jordan; Ch Tech C. McDowell; Ch Tech J. F. Narramore; Ch Tech L. F. Standing; Ch Tech F. B. Wilkinson; Acting F/sgt I. K. Alderman; Acting F/sgt H. F. Appleby; Acting F/sgt K. Carrington; Acting F/sgt J. W. Smith; Sgt H. W. Batty; Sgt M. Belza; Sgt S. F. A. Burr; Sgt J. Emerson; Sgt A. Pritchard; Sgt J. Rae; Sgt G. C. V. Roberts; Sgt P. K. Robinson; Sgt G. J. Salter; Sgt D. Wren; Snr Tech D. S. Hill; Acting Sgt A. W. Bevan; Acting Sgt K. A. Jolliffe; Acting Sgt J. M. Steed; Cpl W. R. Johnson; Cpl A. Sutherland; Cpl R. B. Webb; Acting Cpl A. S. A. Bodman; SAC G. Murphy.

Queen's Commendations for Valuable Service in the Air: Wg Cdr A. D. Boyle; Sqn Ldr P. J. Bardon, DFC; Sqn Ldr J. H. Garstin; Sqn Ldr N. Greenhalgh; Sqn Ldr L. C. Gregory, DFC; Sqn Ldr H. Harrison, AFC; Sqn Ldr R. M. Jenkins, AFC; Sqn Ldr R. A. McPhie; Sqn Ldr F. P. Mulkern; Sqn Ldr J. Primrose; Sqn Ldr P. A. Thomson; Sqn Ldr T. W. Willmott, DFM; Sqn Ldr I. A. N Worby; Flt Lt R. E. Bennett; Flt Lt D. S. Bridson; Flt Lt A. M. Cobban, BSc; Flt Lt R. G. Hanna; Flt Lt W. Hinrichs; Flt Lt D. M. Howorth; Flt Lt D. G. Kinch, DFM; Flt Lt R. F. Lawrenson, DFM; Flt Lt D. F. Mofat; Flt Lt E. Statters; Flt Lt J. H. Turner; Fg Off K. H. Wilson, AFM; M/Plt A. J. R. Baker; M/Plt F. Holliday; M/Plt F. Radina; M/Eng T. L. Salter, DFM; F/sgt J. P. Dunn; SAC E. J. Stewart; Lt Cdr P. B. Reynolds, RN.

FAA Honours—

FLEET AIR ARM officers and ratings named in the New Year Honours list are Vice-Admiral D. E. Holland-Martin, CB, DSO, DSC, Flag Officer Air (Home)-designate, made a KCB; Rear Admiral D. R. F. Cambell, DSC, Flag Officer Flying Training (CB); Capt D. G. Goodwin, DSC, ADC (CBE); and Aircraft Mechanician 1st Class J. F. Brown and Chief Aircraft Artificer M. V. Case, both of whom receive the BEM.

—and Promotions

PROVISIONAL RN promotions, to date from June 30 this year, include the following Fleet Air Arm officers and RN officers serving in aircraft carriers or at air establishments:—

Commander to Captain: W. P. B. Barber, DSC, Executive Officer, HMS *Condor*; J. E. Pope, Executive Officer, *Centaur*; M. W. Peters, Air Engineer Officer, *Victorious*; T. N. Jaggard, RNAY Fleetlands.

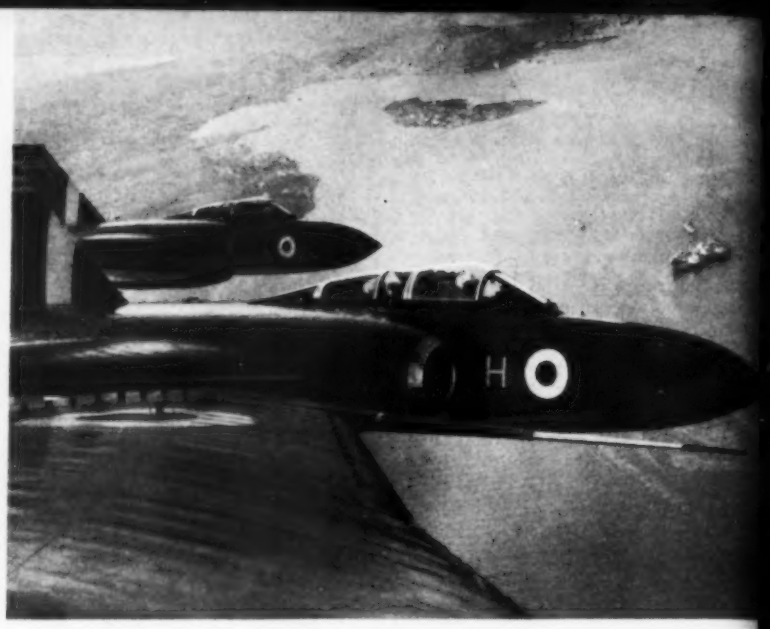
Lt Cdr to Commander: I. R. Bowden, Navigating Officer, *Victorious*; W. J. Cooper, Admiralty (Observers' Appointments); P. J. M. Shevlin, Gunnery Officer, *Victorious*; I. J. Brown, Lt Cdr Flying, *Fulmar*; J. B. Robathan, Lt Cdr Flying, *Heron*, and Flag Lt and Personal Pilot, FOFT; R. W. T. Abraham, Admiralty (Air Warfare Dept); G. R. Higgs, CO 803 Sqn; R. Greenshields, Chief Tactical Instructor, *Osprey*; J. H. Nethersole, Admiralty (Pilots' Appointments); H. G. Julian, DSC, late *Albion*; T. G. F. Hardy, Air Engineer Officer, 892 Sqn, *Heron*; H. K. Dean, Deputy Supply Officer, *Hermes*.

Instr Lt Cdr to Commander: J. A. Moore, BSc, *Condor*; T. O. K. Spraggs, BSc, ACGI, *Falcon*.

Surgeon Lt Cdr to Commander: Surgeon Lt Cdr (D) B. F. Rogers, LDS, *Condor*.

SERVICE AVIATION . . .

Back to Greece—After 18 Years



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VISITORS to Greece by force of wartime circumstance, when their Hurricanes fought the Luftwaffe, No. 33 Sqn—now armed with Javelins—went back to the land of Pericles and Odysseus recently on a mission of goodwill. Taking the form of a visit to the headquarters of the 28th Tactical Air Force at Larissa, it was carried out while the squadron was in Cyprus on a fighter mobility exercise.

Eight aircraft participated, flying from Nicosia at 45,000ft in two boxes of four. They were supported by groundcrew flown in a Hastings of No 70 Sqn. At a luncheon which followed the squadron's arrival, Maj-Gen Exarchakos (C-in-C of the 28th Tactical Air Force) spoke of "the great depth of friendly feeling which exists throughout the RHAF for their comrades in the RAF." Air Marshal Sir William MacDonald, Commander-in-Chief MEAF, echoed the General's sentiments and said that during the war the RAF had received much support both in the Western Desert and in Europe from members of the RHAF. That afternoon seven Javelins flew over Athens in arrowhead formation, and during the evening there was a cocktail party. One of the guests, Maj Voulgaris (who commands the 348th Reconnaissance Sqn), remarked that as a comparatively small boy the sight of No 33's Hurricanes in 1941 led him to join the Air Force.

The squadron's 1959 mission lasted three days, and of it a member wrote: "This, the first full-scale visit of a British Services contingent to Greece since the declaration of the Cyprus emergency, was an unqualified success." These photographs from the squadron's album show (1) the fly-past over Athens; (2) getting together after arrival at Larissa; (3) on the Acropolis during sightseeing in Athens (the CO, Wg Cdr Norman Poole, is on the left); (4) an Anglo-Hellenic group with Col Karakidsos, station commander at Larissa, in the centre.